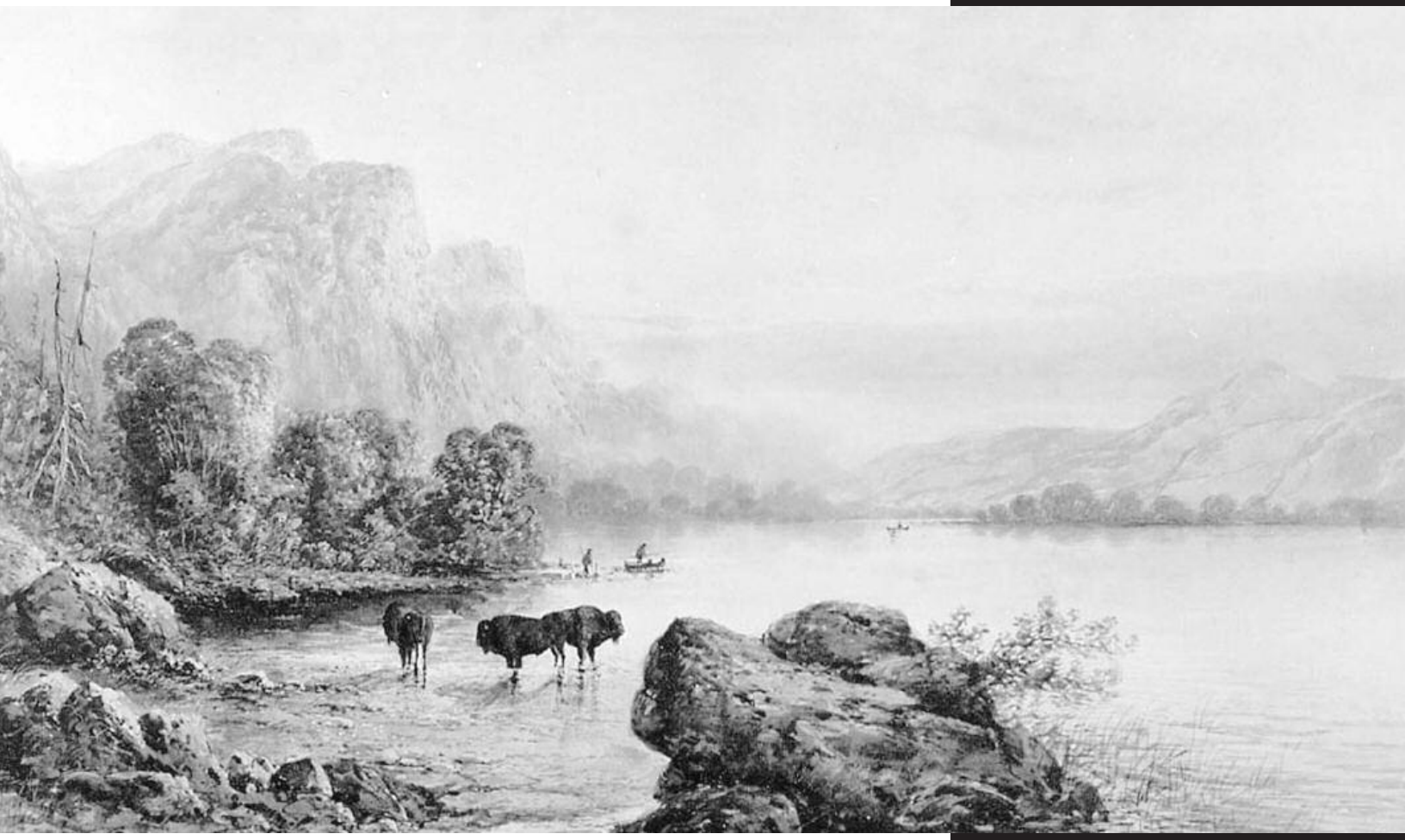
The Land Report

A publication of The Land Institute | Number 73 | Summer 2002



Watershed Democracy:
The Lost Vision of John Wesley Powell

Contents

Our Mission Statement

When people, land and community are as one, all three members prosper; when they relate not as members but as competing interests, all three are exploited. By consulting nature as the source and measure of that membership, The Land Institute seeks to develop an agriculture that will save soil from being lost or poisoned while promoting a community life at once prosperous and enduring.

Cover: Thomas Moran.

Above: Scott Bontz. An annual sunflower to be bred with a perennial opens this spring in our greenhouse.

Back cover: Douglas C. Towne. A wheelbarrow in Arizona makes a statement.

The Land Report is published three times a year.

Editor: Scott Bontz
Associate Editor and Production: Elizabeth Granberg
Graphic Design: Arrow Printing
Arts Associate: Terry Evans
Printed by Arrow Printing Company

THE LAND INSTITUTE

2440 E. Water Well Rd.
Salina, KS 67401
(785) 823-5376, phone
(785) 823-8728, fax
theland@landinstitute.org
www.landinstitute.org

ISSN 1093-1171

Natural Systems of Soil Fertility: The Webs Beneath Our Feet

Christopher Picone

One of the problems of agriculture—whether we consider an industrial cornfield or a typical backyard garden—is that soil is treated like dirt. Most people think of soil simply as a substrate for holding plants in place and for transferring fertilizers. They till it, load it up with fertilizers and pesticides, and compact it with wheels and feet.

How would we treat our soils if we thought of them as diverse ecosystems? That is the approach The Land Institute pursues through a natural systems agriculture. High productivity in natural ecosystems is typically founded on soil communities that are diverse and intact relative to agricultural soils. Healthy soils include abundant communities of bacteria, fungi, nematodes, microarthropods (e.g. mites), macroarthropods (e.g., beetles and spiders) and earthworms. The better we understand the web of interactions among these organisms, the better we can incorporate those webs into agricultural systems that exhibit the efficient nutrient cycling and high soil quality found in most native ecosystems.

The Land Institute is studying one vital part of the soil community, mycorrhizal fungi—those that grow symbiotically with plant roots.

The mycorrhizal relationship between fungi and plants is both ubiquitous and ancient. Mycorrhizae are found in virtually every terrestrial plant ecosystem, including tropical rainforests, temperate prairies and arctic tundra. About 90 percent of plant species, including most crops, form some kind of beneficial association with these fungi.

Mycorrhizal fungi colonize plant roots and rely on carbohydrates (sugars) from their host plants. In return, the plants receive several direct and indirect benefits from the fungi:

■ In most plant species the fungi improve nutrient uptake, especially of phosphorous and nitrogen. The threadlike bodies of fungi, called hyphae, extend from the colonized root into the soil (Figure 1). With their high ratio of surface area to volume, the hyphae are proficient at absorbing soil nutrients and transporting them to the root.

■ In certain cases colonized roots are better able to resist soil pathogens, including nematodes and pathogenic fungi. Mycorrhizal fungi compete with the pathogens for root space, and mycorrhizal roots can exude chemicals that harm pathogenic microbes.

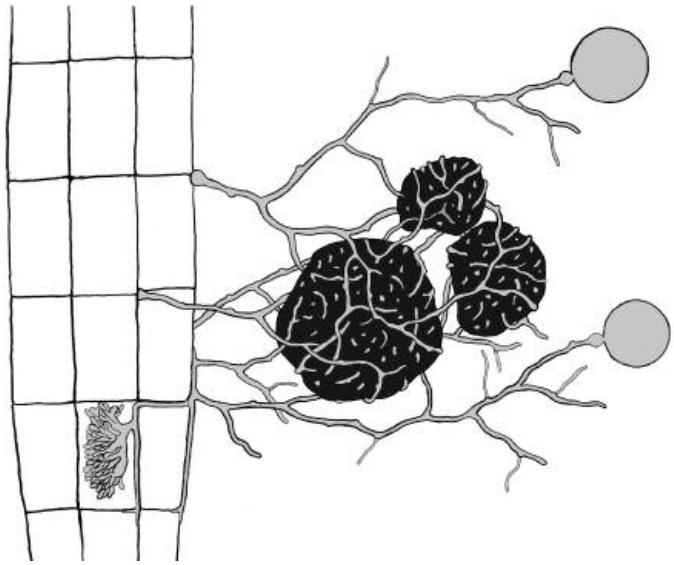


Figure 1. A mycorrhiza, Greek for "fungus-root." The plant root on the left provides carbohydrates to the fungus, while the web of fungus hyphae absorbs soil nutrients and transports them to the root. Nutrients are exchanged via the arbuscle, the lobed structure pictured inside one root cell. The fungus hyphae bind soil particles into the dark aggregates at center. At right the fungus produces spores.

■ Mycorrhizal fungi can help suppress certain weeds. About 10 percent of plant species are non-hosts to mycorrhizae, which means the plants do not associate with nor benefit from the fungi. Many non-hosts are agricultural weeds, including members of the Brassicaceae (mustards), Chenopodiaceae (e.g., lamb's-quarters), Amarathaceae (e.g., pigweed), Polygonaceae (e.g., dock), and Cyperaceae (sedges). Recent studies have indicated that some mycorrhizal fungi can suppress these non-hosts. The fungi seem to drain carbohydrates from the weeds without providing any direct benefit.

■ An indirect benefit to host plants is the role mycorrhizal fungi play in improving soil structure. Consider that a single gram of prairie soil (about the weight of a raisin) can contain 100 meters of threadlike mycorrhizal hyphae. These hyphae form a "sticky string bag" that entangles soil particles and cements them together (Figure 1). Mycorrhizal fungi are considered the most important biological agent for aggregating prairie soils. Such aggregation is what makes a healthy soil struc-

ture—also called tilth. A well-structured soil is loose and aerated. Roots penetrate well, water percolates easily and earthworms burrow unimpeded. Through soil aggregation mycorrhizal fungi form a keystone functional group that influences many soil properties and ecosystem processes.

Modern, industrial agriculture has been able to ignore or subdue natural, beneficial associations such as mycorrhizae by replacing them with inputs from fossil fuels and synthetic chemicals. This process is illustrated with cycles of dependence in Figure 2, a model we have developed at The Land Institute.

In Step 1, tillage crushes soil aggregates, breaks apart the webs of mycorrhizal fungus hyphae, and reduces fungus abundance. We predict that tillage also selects for fungus species that don't aggregate soil particles well. The species that best survive tillage should be those that produce spores rapidly and abundantly, while investing little energy into the hyphal networks that bind soil particles. Fungi that invest primarily in hyphal networks, in contrast, may be most damaged by tillage, not having produced many spores before their mycorrhizal networks are disrupted. By reducing fungus abundance and selecting for ineffective species, tillage probably undermines the biological repair mechanisms required to restore soil structure (Step 2). The soil is left compacted and poorly aerated, requiring further tillage to loosen it (Step 3). In this cycle, tillage induces the need for more tillage.

Tillage also promotes dependence on fertilizers. By reducing abundance of mycorrhizal fungi, tillage undermines the biological mechanisms for nutrient uptake (Step 4). Modern agriculture compensates by applying synthetic fertilizers (Step 5). These fertilizers—unlike organic fertilizers—further reduce the abundance of mycorrhizal fungi, and they select for fungus species that are ineffective at nutrient uptake (Step 6). Synthetic fertilizers induce the need for more fertilizer.

By generating a soil with an impoverished mycorrhizal community and excess nutrients, industrial agriculture creates an optimal environment for non-host weeds (Step 7). The fungi are less abundant and therefore less able to suppress these weeds. More importantly, non-host weeds have a competitive advantage over host plants in soil with excessive nutrients, because the weeds do not have to pay the carbon cost to the fungi in order to take up nutrients. As biological mechanisms for weed control are undermined, we compensate with herbicides (Step 8) and even more tillage (Step 9).

In sum, the inputs from industrial agriculture induce the need for more industrial inputs, mediated by impacts on the soil community. Like drug addicts dependent on their chemicals, industrial farms rely on ever-increasing inputs for high productivity. Also analogous to the drug addict, the farm must undergo rehab when the chemical inputs cease. During that period farm productivity often plummets until the soil re-establishes the biological net-

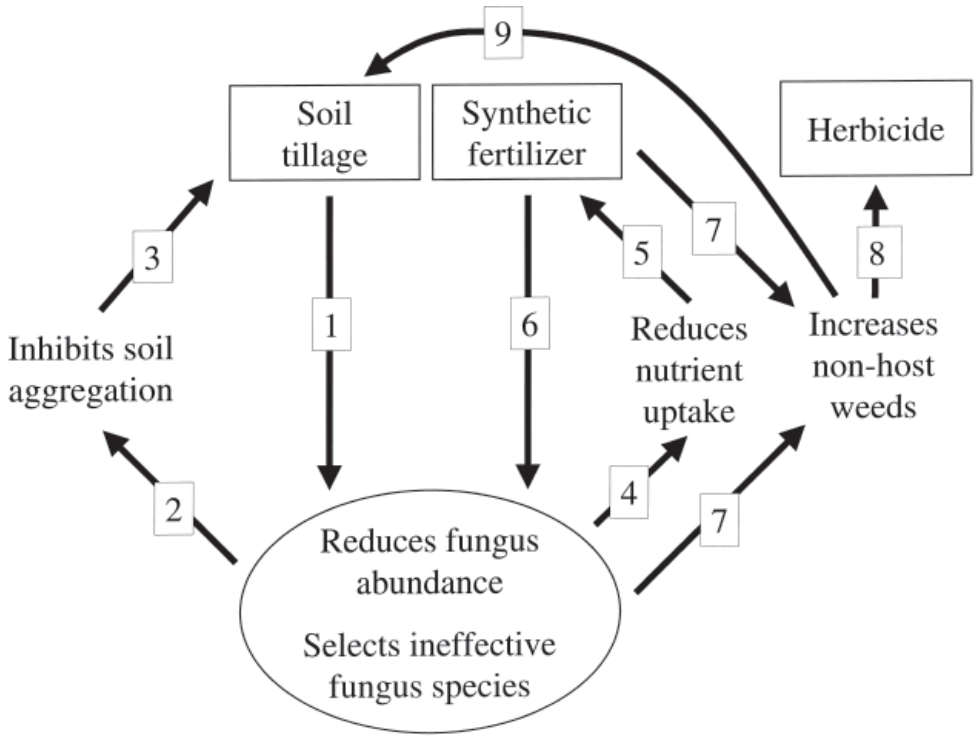


Figure 2. A model for the effects of industrial inputs on the mycorrhizal community. See text above for more.

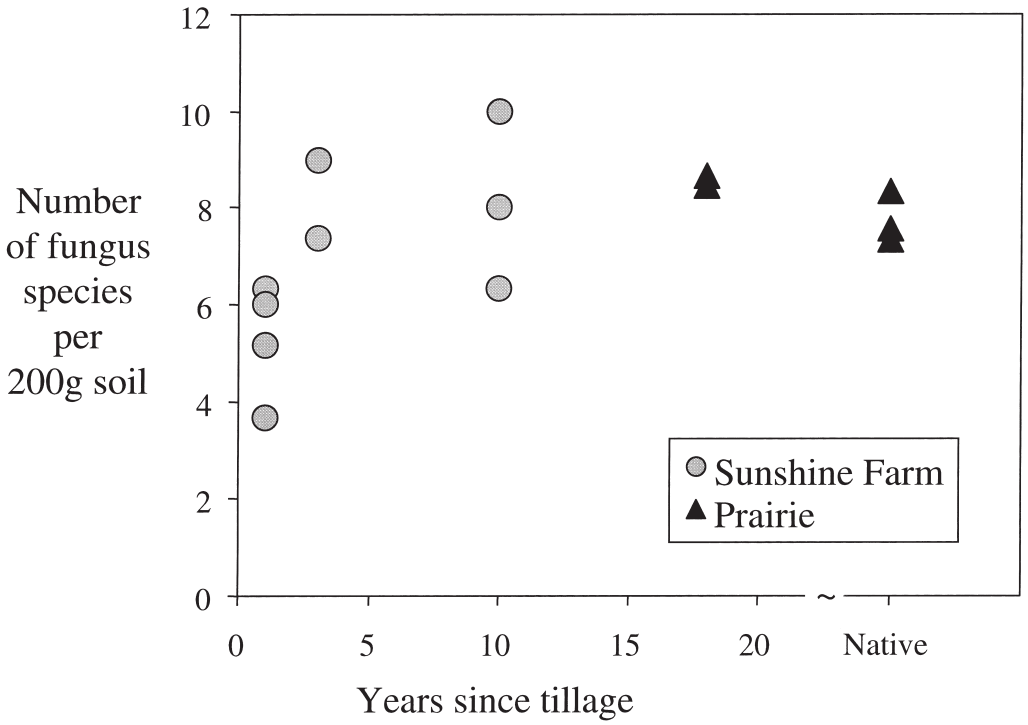


Figure 3. Annual tillage reduces the diversity of mycorrhizal fungi. Each point represents the average number of fungus species from several different soil samples taken in the same plot. Note how, after very few years without tillage, diversity rebounds to levels equivalent to the native prairie.

works for improving nutrient uptake, soil structure and weed control.

One of the goals of Natural Systems Agriculture is to understand how we can rapidly restore and maintain the biological networks of a healthy soil. As part of this goal, our research on mycorrhizae has two strategies. First, we are asking how different agricultural practices affect the community of mycorrhizal fungi. When native systems are converted to agriculture, the soil is typically plowed, the plant diversity is reduced and the plant community is replaced with different species. Our research addresses how each of these changes can alter the soil fungus community. Second, we are asking which changes to the fungus community are most important for plant growth and soil quality. Which species or genera of fungi are best at providing nutrients, suppressing weeds or aggregating soil? With answers to these questions, we can begin to use specific practices to promote optimal communities of soil fungi.

To determine the effects of tillage, we have sampled soil in tilled, restored and never-plowed plots. Results show that soil disruption indeed harms the fungus community. On average, tillage reduces diversity by about 27 percent. This impact is seen in data from our Sunshine Farm (Figure 3). Plots of annually tilled crops were compared with untilled plots of perennials. These treatments were also compared with prairie—the standard we try to mimic. It is encouraging to note that after only a few years without tillage, soil with perennial plants can have a fungus community that is equally diverse as native prairie. Future fields of perennial polycultures will not require decades to restore this component, at least, of a healthy soil network.

Christopher Picone. A root of bindweed heavily colonized by a mycorrhizal fungus. The fungus, stained dark with ink, has produced small sporelike structures both inside and outside the root. It is not yet clear if the fungus helps or hurts this weed.

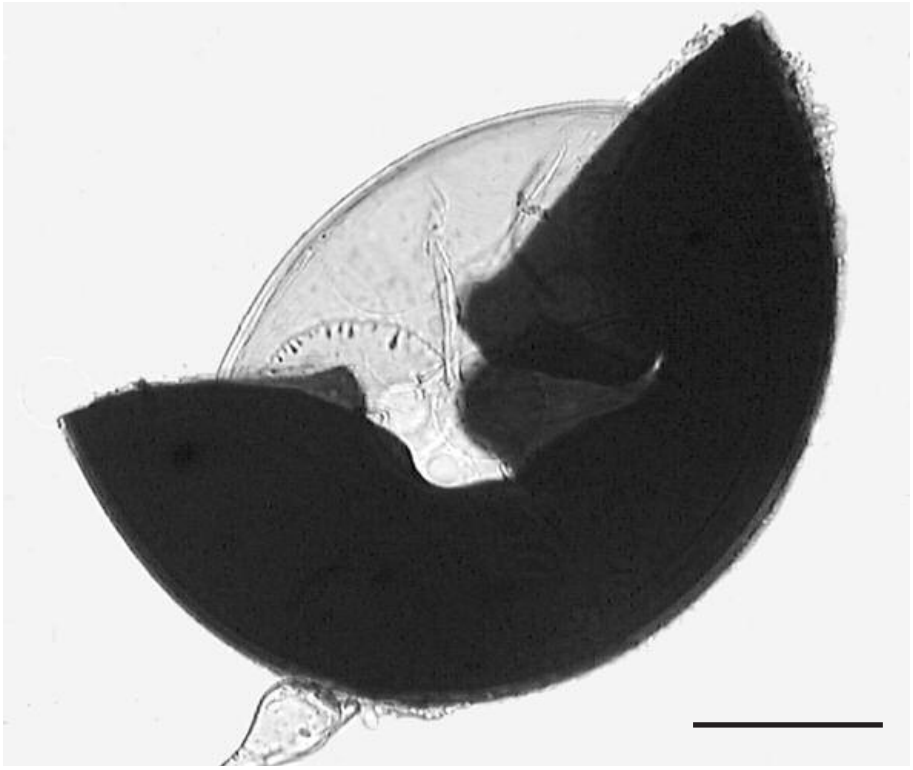
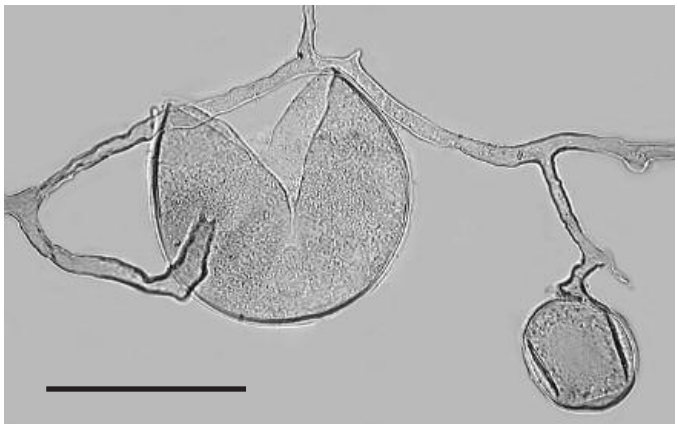


Figure 4. Spores are the primary means used to distinguish mycorrhizal fungus species. Spores are spherical, but here have been squashed and broken under microscope slides. Note the simple structure of the spore walls of *Glomus*, below, relative to the multilayered walls of *Scutellospora*, left. Just left of center on the *Scutellospora* spore is a germination shield, a structure unique to this genus. The bar in each picture is 100 microns, or one-tenth of a millimeter

We have found that tillage also modifies the relative abundance among fungus species, i.e., the most abundant species in a plowed field are different from those dominating unplowed soil. Tilled soils tend to promote species in the families Glomaceae and Acaulosporaceae, such as *Glomus intraradices*, pictured in Figure 4. Soils that are unplowed tend to favor species in the Gigasporaceae, such as the other pictured type, *Scutellospora pellucida*. To test our model in Figure 1, we need to determine if the species promoted by tillage are indeed relatively ineffective at improving soil structure.

Unlike tillage, plant diversity has no apparent effect on the mycorrhizal fungus community. We have compared plots of monocultures with polycultures, and in no case did plant diversity influence fungus diversity. In fact, fungus diversity in some perennial monocultures equaled that of native prairie. This result is probably peculiar to mycorrhizae—crop diversity generally influences other microbes, such as bacteria and soil pathogens.

Although mycorrhizal fungi do not seem affected by plant diversity, they are affected by plant species identity. We recently harvested a two-year experiment comparing fungi associated with particular plant species and functional groups. Twenty-two plant species in four functional groups—warm and cool-season grasses, legumes and composites—were grown in pots with a diverse, homogenized soil inoculum. Preliminary results indicate that spores of a few fungus species are especially abundant with some plant groups, such as warm-season grasses. The abundance of other fungi, in contrast,



depends more on particular plant species than on functional group. For example, samples from the legume Illinois bundleflower have 20 times as many spores of *Gigaspora sp*. as do most other plant species. The second-best host for this fungus is Canada wild rye—a cool-season grass, not another legume.

This study also suggests that a plant's dependence on mycorrhizae has little relation to the species of fungi that thrive with it. For example, Illinois bundleflower is obligatorily dependent on mycorrhizae in order to grow, while Canada wild rye receives no apparent benefit from fungus colonization. Moreover, species that are hindered by mycorrhizae, such as smooth brome, foster surprisingly diverse fungus communities.

As we better understand how plant species help determine the fungi beneath them, we can begin to improve the soil community by choosing certain plants for crop polycultures. If *Gigaspora sp*. is indeed very

effective at improving soil structure, as our model predicts, then Illinois bundleflower could be used to promote it. Similar examples will emerge as we learn which fungi are most effective at other functions.

Our work on the relative effectiveness among fungus species is in its infancy. We have had considerable difficulty isolating and propagating pure cultures of each species, which is a necessary first step to experimenting with them. Our techniques are improving, but we have far to go.

Promising experiments have been with weed control. A summer assistant, Alyssa Irlbeck from Austin College, Texas, initiated a study on the ability of mycorrhizae to control bindweed, *Convolvulous arvensis*. This pernicious weed is common in plowed fields and very rare in prairie. Conversely, the fungus *Gigaspora gigantea* is the dominant species in prairie but is absent from the tilled fields at The Land Institute. Could this fungus be suppressing bindweed in prairie? Our experiments indicate a "maybe." In one study, when bindweed grew in pots with sorghum, the prairie fungus reduced bindweed growth by half. In another study, however, when bindweed grew alone, the fungus had no effect. We are currently testing if the presence of a good host plant, such as sorghum or Illinois bundleflower, is needed for the fungus to suppress weeds like bindweed.

Despite these promising results, several caveats are needed in regards to applying mycorrhizal research to agricultural systems.

First, we are trying to understand the ecology of mycorrhizae, not develop a new agricultural input. Too often, well-intentioned research tries to replace synthetic chemical inputs with biological inputs. Farmers already are dependent on too many inputs. We are *not* trying to grow gee-whiz strains of fungi that can be sold as "biofertilizers." We *are* trying to understand how farmers can better manage the soil community they already have, and restore it through NSA. For highly degraded soils, some large-scale inoculation may be needed to get things started, but it should be designed to be a one-time event.

Second, mycorrhizal ecology provides a way to dramatically improve the *efficiency* of energy and nutrient use in modern agriculture, but it will not improve *productivity*. When people learn that these soil agents can act as biofertilizers, they often assume such fungi can completely replace synthetic fertilizers. Not true. Any natural system, even a prairie, will increase productivity if saturated with synthetic fertilizer. We cannot expect to compete in terms of productivity with industrial systems that are trying to obtain 400 bushels of corn per acre. (To return to the drug addict metaphor, the non-user may not achieve the emotional high that the addict can achieve, but the non-user is a lot less likely to drive his car into a tree.) Only when we consider the environmental impacts of focusing solely on production do we realize that efficiency deserves at least as much attention. In terms of the efficiency, Natural Systems Agriculture will blow away any competing system. As a result, it will also outproduce any competitor over the time scales that humanity should be thinking about—centuries and millennia.

As a final caveat, please don't call The Land Institute and ask exactly how to optimize the mycorrhizal fungus community in your garden or farm. We are only beginning to answer some questions unique to our place, and we won't be confident with even those answers for years. Like the breeding program for perennial grain crops, our research may require decades before mycorrhizae can be incorporated into a productive, sustainable, commercially viable Natural Systems Agriculture.

But humans have been treating soil like dirt for 10,000 years. A few decades seems a reasonable amount of time to reverse millennia of ignoring and subduing the webs beneath our feet.

This study has been supported by a grant from the Charles A. and Anne Morrow Lindbergh Foundation.

Scott Bontz. Chris Picone sows seeds of a perennial plant mixture at a research plot. In this experiment we are studying how soil disturbance—tillage—and plant habit— perennial or annual—affect soil microbes. Small plots of native prairie are paired with adjacent plots of recently plowed prairie. Each plot is further divided into a half with annual crop mixtures and half with perennial mixtures.

Watershed Democracy

Recovering the Lost Vision of John Wesley Powell

Donald Worster

In the American environmental movement, two figures stand like gods, gathering followers and handing down sacred texts: John Muir, the lanky, bearded rambler of the West and prophet of the wild, who founded the Sierra Club, and Gifford Pinchot, the well-groomed, patrician advocate of wisely using the nation's natural resources, who founded the U.S. Forest Service.

The problem with this picture is that neither man's shadow covers the wide middle ground where most of us live. Less than 10 percent of the country is protected by national parks, wildlife refuges, or wilderness areas. Only a third of the country is owned by the federal government and directly managed—however well or badly—by government agencies. Who then is there for the *inhabited* United States, telling us how to live successfully within our locality or region, pointing toward an enduring partnership between humans and the rest of nature?

I have no new saint to promote, but I do want to suggest that a 19th century contemporary of Muir's and Pinchot's deserves better notice today. John Wesley Powell introduced precisely that environmental ideal that we have long needed but have never really achieved for the nation's inhabited landscape: watershed democracy.

Revised and updated for our day, watershed democracy can comprehensively and practically incorporate Alice Hamilton's quest for environmental justice, Aldo Leopold's land ethic and Rachel Carson's plea for ecological health. It can link soil and water conservation to a more ambitious, integrated program of environmental restoration. It can provide a common cause for biocentrics, who argue that we should put the natural world at the center of our moral concern, and anthropocentrics, who want to keep humans at that center. Finally, watershed democracy can engage the rural landowner while acknowledging that we are now an overwhelmingly urban people. It is an environmental vision that city as well as country people can find meaningful.

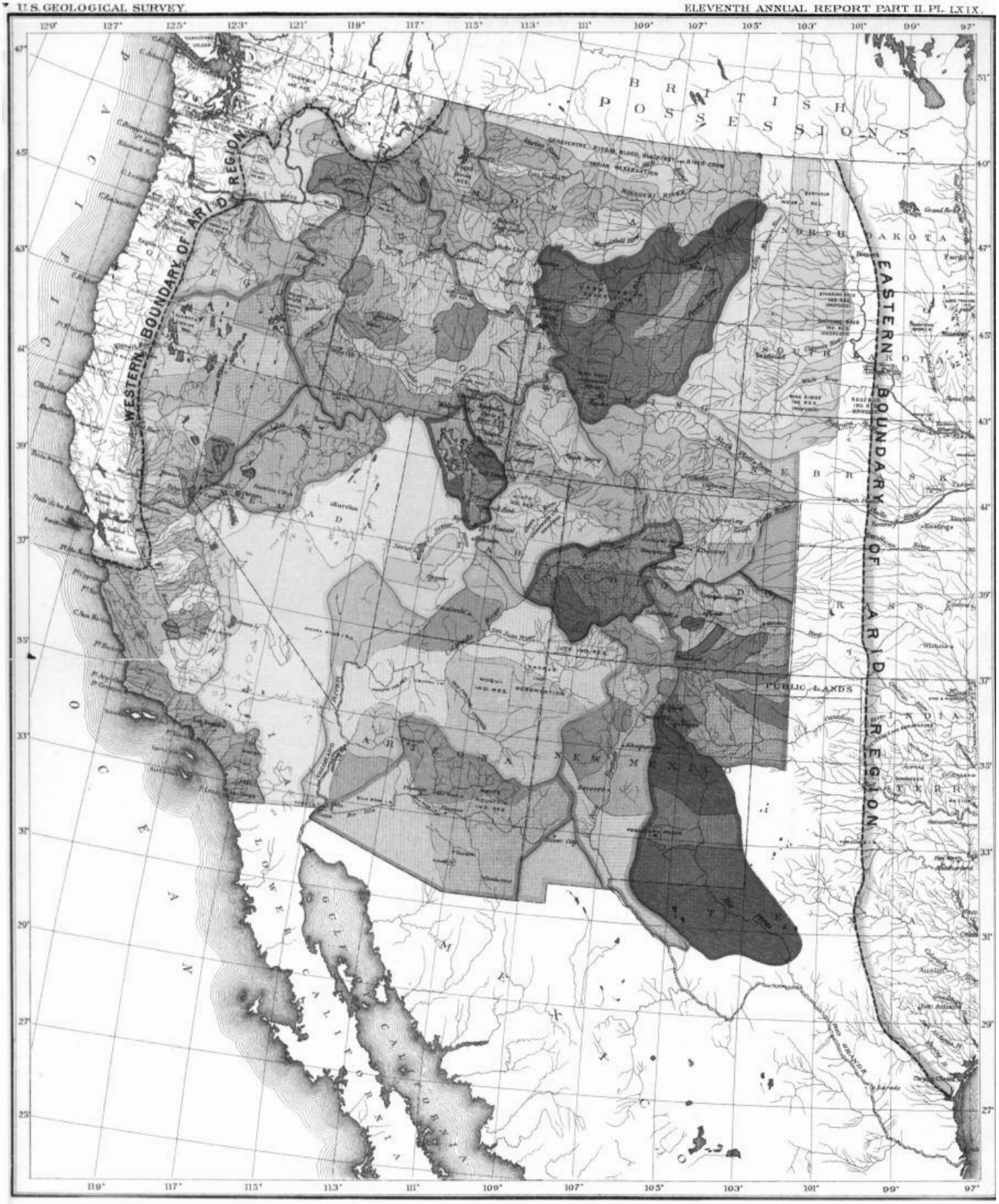
Who was this prophet of the watershed? Powell, who died in 1902, a century ago, was born in 1834, the product of evangelical Methodists who emigrated from England, and of the wide prairie farmlands and stately rivers of the Middle West, growing up in Ohio, Wisconsin and Illinois. Although as a young man he walked behind a plow and threshed wheat, he chose not to make farming his life work. After losing part of an arm in the Civil War, he headed west toward canyon lands and mountains, seeking to make a name for himself in science and discovery.

In 1869 Powell led 10 men in four wooden boats on the first scientific expedition down the unexplored Colorado River passage through Glen, Marble, and Grand canyons. It was a bone-wearying and tension-filled three-month voyage, near the end of which Powell lost three men to mutiny. What he won, after so much brutal effort, was national fame—so that ever after the Colorado would belong to him as much as the Missouri and Columbia would belong to Lewis and Clark.

Posterity, however, has not remembered well the post-1869 Powell, the man who came back again and again to understand the fuller nature of the West. He was determined to know what potential the new country had for America, particularly for its rural people hungry for a secure place on the land.

Looking at the West through agrarian eyes, Powell saw a more formidable challenge than many of his contemporaries wanted to admit. It would be difficult, he realized, to extend beyond the 100th meridian America's traditional dreams of democratic society, private property, and self-reliant and prosperous producers. Past that line, the water gets more and more scarce, until in places it vanishes from the earth's surface. Farmers in the East faced the growing power of railroads, grain dealers and other middlemen who were beginning to take most of the wealth out of their hands. Farmers in the West would have to confront the added threat of scarce rainfall.

Right: University of Kansas. Powell sought to educate Americans to think in watershed terms with appealing, informative maps of the natural topography. With contour lines they showed the shape and elevation of place, its natural divisions, and its articulation with other places, and with colors the place's ecological zones and coordinated uses.



ARID REGION
OF THE
UNITED STATES
Showing Drainage Districts.

Scale:

"Fix it in your constitution

that no corporation—no body of men—no capital can get possession and right to your waters. Hold the waters in the hands of the people."

The greatest danger was the ease of monopolizing such a scarce necessity. In 1890 Powell told the North Dakota constitutional convention, "Fix it in your constitution that no corporation—no body of men—no capital can get possession and right to your waters. Hold the waters in the hands of the people."

He was aware that putting a few words into a state constitution would not offer sufficient protection. Every state must also empower its residents with knowledge and authority to govern the use of land and water. Democracy, as Powell understood it, requires more than half-attended, half-ignored rituals of political campaigns and elections. It must be built on a secure environmental foundation. All land and water must be put under the control of all the people, who then must want to safeguard that shared heritage. Because in his day most Americans were agriculturists, he argued that land and water must be put securely into the collective hands of small farmers.

At the core of Powell's thinking was a revolutionary perception of the landscape. He saw America as a series of watersheds more vital and significant than any artificially constructed political unit. Pointing out that nature follows its own demanding logic, he warned that the very shape of a human community, the shape of its rights and rules, must be tailored to that logic. Communities must be adapted to the watershed around them.

By watershed I mean the land area that drains to a single body of water—a river, marsh, or estuary. Sometimes called a catchment basin, a watershed may be as large as the Mississippi River's, which drains some 40 percent of the country, or as small as an upland rivulet draining a few hundred acres. Powell studied watersheds on all those scales, founding a new science of dynamic topography and promoting a new way of conceptualizing that abstraction we call the American land.

In 1890 he began laying out his vision of a watershed democracy in speeches before state constitutional conventions, in the *Century* magazine, and in congressional testimony. He recommended that the West be settled not acre by acre, but watershed by watershed. Settlers should enter a watershed only after it had been carefully surveyed and described on a scientific map, and then they should hold that unity of land and water in common. They should make rules for each kind of ecosystem within their watershed: the high mountain slopes covered by forests, the mid-level grasslands and the rich alluvial bottomlands. Powell advocated setting aside the first of those types, the mountain forests, as common property, with local supervision to control fires and lumbering. On the middle terrain he suggested the grazing of livestock under rules that would prevent overstocking and erosion. The bottomlands were where the people's homes and fields should cluster—farms and communities down where the creeks and rivers ran, where people could irrigate crops.

Respecting the watershed requires first being able to see it, which has not proved easy to do. We readily see a forest or rocky cliff, or a river running through meadows or hills. But seeing the entire watershed takes training—takes the aid of modern science. For Powell, who became director of the U. S. Geological Survey in 1881, educating Americans to think in watershed terms depended on making appealing, informative maps of the natural topography, showing with contour lines the shape and elevation of place, its natural divisions, its articulation with other places, and with colors the place's ecological zones and coordinated uses.

Undoubtedly Powell's vision owed much to the example of Mormon Utah, whose settlement patterns he observed closely during the 1870s. He drew on that particularly in writing his famous 1878 Report on the *Arid Lands of the West*. But there was another influence that was at least as important as the Mormon example: the philosophy of democratic agrarianism, or populism.

Populism, like its predecessors the Grange and Farmers' Alliance movements, was criticized for standing against progress, for bigotry toward the cities, for cranky, ignorant self-righteousness. More recently, historians have revealed Populism as more forward-thinking, creative and progressive. Overcoming their deference to the seats of power and privilege, the Populists

set out to stop the drift of the country toward corporate control and centralized ownership. Their most important instruments of resistance were producer and consumer cooperatives, self-organized and self-managed at the grass-roots level. Then they pushed on into politics, calling for democratic ownership of the means of production. The platform drawn up in 1892, the year they nominated their first candidate for the presidency, demanded a graduated income tax and said that "the land, including all the natural sources of wealth, is the heritage of all the people, and should not be monopolized for speculative purposes."

The Populist movement roared through the late 1880s and early 1890s, when Powell was developing his vision of watershed democracy. Earlier, as a young man, one of his key influences was brother-in-law John Davis, a farmer, newspaperman, and brilliant critic of corporate power, twice elected to Congress on the Populist ticket. In working to prevent the arid West from becoming, in effect, the property of an economic elite, Powell was in league with Davis and the rest of the Populists, all of whom were intent on getting railroads, banks and marketing under the control of farmers or their elected representatives.

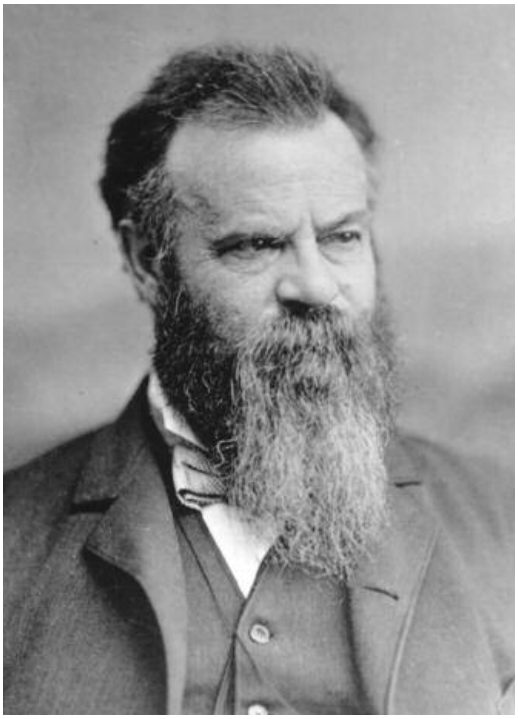
So far as I can discover, Powell was never active in the Populist movement, and it seems unlikely that this lifelong Republican would have voted for a Populist presidential candidate such as William Jennings Bryan. There was in Powell, it must be said, a contradictoriness. He was inclined to celebrate the advance of industry and the rise of scientific expertise, and even to see the trend toward corporate power as preparing the way for a more collectivized future. But when he came to think about Western land and water, and about the best way to inhabit the watershed and govern its use and development, Powell thought like a Populist.

In 1896 the party was defeated in national elections. After that it faded away, leaving behind a name that has often been resurrected only to be misunderstood. Real, genuine populism is no longer a force in the West or the South or any other part of the country.

So also was Powell overwhelmed and defeated, until like the Populists he faded from memory. North Dakota ignored him completely in drawing up its constitution. So did Montana, Idaho, Nevada and every other Western state. And so did Congress, which went on as it had always done, parceling out land with no water rights attached, disregarding the lay of the land in its land disposal policies, and stubbornly insisting on old ideas of private property and straight fences. Powell eventually retired from government and, disillusioned by his failure to put the West on a revolutionary ecological and political course, went home and shut up.

I have been recalling ideas and movements that rose and fell more than a hundred years ago. You may be thinking that the past is irretrievably gone. Since Powell's time the West, indeed the whole of the United States, has changed dramatically. When he saw it, the West was scarcely populated, and the total size of the United States was less than 100 million. Today many watersheds on the Western side of the continent are brimming with people, while the nation as a whole has swollen to nearly 300 million.

When we look at that heavily populated United States of today, we must admit that the patterns of land and water use, and of ownership, have become less, not more, democratic. In most Western states, whoever got



Portraits 2, USGS Photo Library, Denver. Pointing out that nature follows its own demanding logic, Powell warned that human community should be tailored to follow.

there first and claimed the water still, in a sense, controls its destiny by passing the claims to heirs or selling them to corporations. In some places those rights of possession have passed to metropolises, which can take water completely out of its watershed, across valleys and over mountains, and sell it as an abstracted commodity to thirsty consumers. Seldom do we see any strong local or community ownership or management.

True, there are irrigation districts where, at least nominally, farmers hold water in common, though not the whole watershed, and where they make collective decisions about its use. In practice, however, many of those farmers have become wealthy businessmen, not a few of them absentees, and the districts have become powerful water-controlling corporations. Such powers commonly lock out of their boardrooms most of the residents who live within the watershed.

Also, over the past hundred years state and federal bureaucracies have acquired much power over water by means of the dams, reservoirs and levees they have built. Chains of command go from riverbank to regional office to headquarters, and it is in that headquarters, often shielded from public view, where professionals and technicians make important decisions.

Above: E. O. Beaman, USGS Photo Library, Denver. Powell has been remembered mostly for his pioneering 1869 boat trip down the Colorado, not for his repeated returns to know the West's potential, particularly for rural people hungry for a secure place on the land.

With water, we have at best the shadow of democracy. We do not have Powell's watershed democracy shaped to the contours of the land, with full and effective community participation. The water that flows past America's millions is not, in any meaningful sense, their water. It seems to belong to somebody else. It is managed by forces and powers beyond them. It is disconnected from most of the decisions made on the land. Where do we actually vote on water or the watershed? Who do we hold responsible for what happens to the environment in which we live our daily lives? How do we learn to behave responsibly when our connections to the land have become so weak and remote?

Changes toward more concentrated power and control, toward metropolitan and industrial growth, are responsible, I believe, for much of the degradation of the American environment. Polluted streams, overdrawn and depleted resources, flood-plain mismanagement, a plague of eroding soils, and a severe loss of wildlife habitat—all this we see around us today, and all this despite a hundred years of environmental legislation.

In 1972, Congress passed the Clean Water Act "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Every river, it promised, would soon be safe for fishing and swimming. Despite making some significant progress, only about half of our rivers meet the 1972 goal. Powell's old agency, the Geological Survey, reports that between 900,000 and 2 million people become ill each year by ingesting protozoan, bacterial and viral pathogens in incompletely treated water. Then there is that ghastly brew of petrochemicals, nitrogen fertilizers, pesticides

and endocrine disrupters suspended in our waterways, more of them in fact than there were in Rachel Carson's day.

The damage done to the other-than-human world may be even more severe than that done to our own health. According to the Pacific Rivers Council, in their recent book, *Entering the Watershed:*

From one-third to three-fourths of aquatic species nationwide are rare to extinct, and aquatic species are disappearing at a faster rate than terrestrial species. An estimated 70-90 percent of natural riparian vegetation, vital to maintaining the integrity of riverine-riparian ecosystems and biodiversity, has already been lost or is degraded due to human activities nationwide.

When we move away from riverbanks and in-stream water quality to survey the entire watershed, we find increasing loss of agricultural lands and wildlife habitat to urban sprawl. We find more soil erosion occurring than ever before in our history. According to the Global Change Research Information Office, the nation's soil is eroding at about 17 times the rate at which it forms. Net loss occurs on 90 percent of our cropland. The Natural Resource Conservation Service says 108 million acres have excessive erosion, losing 1.3 billion tons of topsoil each year.

These facts argue that we need a better way than we have found to address the intertwined problems of water quality, public health, habitat diversity and soil protection. Our persistent environmental problems are often local, and they defy the attention and the competence of the individual landowner and the badly fragmented bureaucracy. City and county planning commissions are of little help, for they narrowly focus on subdivision platting, traffic flow, and sewage disposal. The Department of Agriculture's conservation districts, dating back to the 1930s, are limited to farm owners; they lack a comprehensive foundation in both the human community and the natural watershed.

Because of this continuing impasse on significant environmental improvement, a movement is stirring across the United States to embrace the idea of the watershed. Many state natural resource agencies have come to see that the watershed is the best management unit. At the same time thousands of non-governmental watershed associations have formed, seeking to educate themselves about their environment, to promote a more integrated approach to conservation, to lobby for better land and water regulation, and to restore watershed health. The Environmental Protection Agency says nearly 3,000 such organizations now exist nationwide. In June 2001, nearly 500 of their representatives gathered in Arlington, Virginia, for the first National Watershed Forum.

So far these groups seem to be little more than clusters of devoted activists who can claim no political authority, do not represent the whole electorate, and tend to focus only on quality of the water, not of the land. Only in the state of Nebraska do we see anything like Powell's vision being realized. Since 1972 Nebraska has been developing a genuine and far-reaching watershed-based system of governance, dividing the state into 23 natural resource districts with fairly broad powers over all resources. What is needed is a new set of public institutions, matching and surpassing those of Nebraska, all across the nation, new institutions charged with protecting the beauty, integrity and long-term productivity of watersheds.

We might begin by going back to Powell's idea of designing the best possible watershed maps for the people—lovely, attractive, informative maps. Such maps should hang in every school building, civic meeting place, and assembly hall. Topographic intelligence must be followed by new arrangements of power. There is a danger in the watershed concept that it could become the exclusive province of technical experts, undermining democratic participation. To prevent that we need to establish for every watershed in America a governing board answerable to the citizenry, backed with adequate revenue, and responsible for setting up comprehensive environmental standards. Our democratic traditions tell us that each resident of each watershed should have a voice in setting those standards.

I have no elaborate blueprint to offer for achieving that new environmental ideal. One should emerge from the citizens themselves. It is they who must decide how such watershed governance would fit in with or relate to existing structures of government. I sense that Americans are groping toward a new environmental politics that is broader than agrarianism, broader than environmental justice, broader than wilderness preservation and more sensitive to environmental realities than our current fragmented and out-of-date political system. They are groping toward a new structure of policy-making that, ideally, would give every citizen a better chance to be involved in vital decisions over land and water at the local and regional level. They are looking for a concept as bold as those that excited John Muir and Gifford Pinchot.

The watershed is that concept. It has taken us more than a hundred years to rediscover the vision that John Wesley Powell brought out of Utah and the canyons of the American West, and out of his Midwestern populist sympathies. The watershed, we can faintly hear him saying, is the place we inhabit on earth. It is the place we must learn to live within and where we learn to live with each other. The watershed is the natural home of democracy.

A version of this essay was presented at the 2001 Prairie Festival.

El Cerrito y la Acequia Madre

(The Little Hill and the Mother Ditch)

Sharon Stewart

In most of Hispanic northern New Mexico, interdependence on the community irrigation ditch, or *acequia*, is a defining aspect of village life. No one is certain of the acequia's origins in El Cerrito, an isolated village of the arid Pecos River Valley. Some speculate that the first peoples created the gravity flow system. Others believe Franciscan priests dug the ditches when colonizing for Spain, thus securing two crucial elements of village life, faith and water.

Each spring the *limpia*, or cleaning, of the acequia is the responsibility of the *parciantes*, water rights holders. The parciantes adhere to a governing structure dating to the Moors, who established acequias in Spain during their seven-century occupation. In the early 1960s, with the village population at its nadir, the arduous, essential task of clearing river debris, rocks and beaver damage required every weekend in April. The limpia now takes less than a day. It is the one social gathering outside the rare wedding and more common funeral for which all manner of people come to El Cerrito for the common goal of preserving the ditch to ensure water for their fields and livestock.

El Cerrito's survival is partially due to the early 1970s migration to northern New Mexico by people seeking a simpler existence. Several friends came upon El Cerrito, persuaded a villager to part with his land and water, created a tenants-in-common living situation and settled into rural lives. Other village residents, gone to cities for employment, have returned through the years to renovate family homes for retirement. The once insular Hispanic village is now a residential amalgam of original family descendants, several tenants-in-common and friends.

The acequias of New Mexico are the Southwest's oldest extant water system, remaining a cherished cultural component to the persistence and vitality of the region's agrarian communities, and illustrating the universal truism: *Agua es vida*—water is life.

Compuerta

Abran and Vidal

An Agrarian's Gift

Dean Hulse

In the late 1960s our oat crop got hit by rust, a fungal disease that can devastate cereal grain. We were lucky. We had some oats left to harvest. When I swathed those oats, my arms, my clothes and our swather itself were coated with a reddish-brown powder at day's end. Blowing my nose yielded auburn mud.

Disease was only one among a plague of discouragement for my father on his farm: 30-minute downpours that made lakes of fields, drowning plants and hopes; drought and relentless, mocking wind that turned our coarse soil into dust and black beaches where nothing would grow except despair; grasshoppers with pincerlike mouths that scythed maturing grain heads; unseasonable cold that shut off plants' life flow like a hand to a faucet.

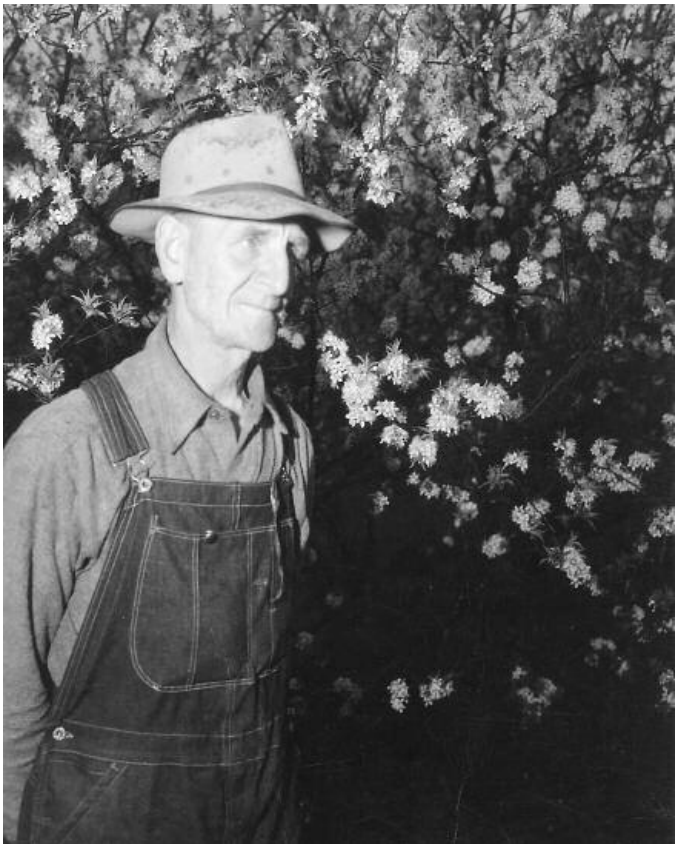
Unmanageable unknowns are a commodity that farmers get in abundance. In this respect, farming is both unique and unalterable, and as such, it requires the commitment of an artist who seeks payment in kind more often than remuneration. Despite nature's disastrous assertions, my dad was one of those artists. Another was Sam Lykken.

I don't know if Lykken had any truck with the art world and the abstractions and intangibles therein. I never met him. But I trust that through all the burdens and benefits of being on the land—not only the sweat and fatigue, but also the feelings of fear and doubt, of determination and satisfaction—he became thoroughly a part of it. And I know this: he produced a miraculous masterpiece.

In 1992, I was working as a reporter for a regional farm publication. On a tip from a university researcher, plant pathologist Brian Steffenson, I set up an interview with Sam Lykken's sons, Percy, the eldest, and Sam Jr. Steffenson wanted to speak to Lykken's sons and to see the site of his accomplishment. We met at the former Lykken farmstead about three miles east of Kindred, North Dakota.

Lykken's sons said their father was a meticulous man. Although by the mid-1930s he used a tractor for plowing, disking and harrowing, when it came time to plant, he parked it and hitched up the horses. Sam Jr. said, "He was very, very fussy about planting."

In the mid-1930s Lykken seeded 20 acres to barley only to see stem rust strike before the plants headed, leaving them unharvestable. The field lay along a lane to the county road. He would have seen it to the east as he drove to and from church on a particular Sunday morning.



What he was thinking that day remains a mystery, even to his sons. But his routine remained recognizable. After dinner, he went for a walk to check his fields—even the rusted-out barley field. A casual observer would conclude quickly that the crop was a lost cause. But Lykken walked into that field. I think he went because he was an artist. In looking at it, he was looking at himself. With an average yield, he should have seen 12 million to 13 million healthy plants. Instead, the scene was one of devastation: stunted yellow, orange and brown plants. But in its midst he saw still standing one green survivor. This would prove to be an agent of salvation.

Above: Courtesy of Sam Lykken Jr. Sam Lykken found in his diseased field one remarkable plant that has helped for decades avoid the same ruination.

Lykken encircled the healthy plant with a fence of coarse screening. Sam Jr. said, "I remember how excited he was because we all had to go out and look at it."

Neither of Lykken's boys chose to farm. They spoke of their experiences on the farm without implication. They told of hauling water to keep 600 Chinese elms alive through a summer when grasshoppers flourished instead of crops. I could imagine the muscle-burning pain of hauling pails of murky water up the Sheyenne River's steep, hot, mosquito-infested bank. Their chores and their challenges echoed stories of thousands of farm boys who've gone on to greener pastures since the 1930s, the decade when North Dakota's farm population peaked.

With guilt still in his voice, the younger Sam Lykken also told of his neglectfulness with a stubborn lawnmower producing tall grass that attracted their cattle. "Dad planted the barley he'd saved in our garden," he said. "The cows got into the garden once and almost ruined it. I know it set him back a year."

In 1992, in what had been their father's barley field, as rainfall spotted their jackets and their eyeglasses after a years-long drought, I read in the Lykkens' expressions a mixture of regret and relief, probably because that is how I often feel about having left the farm. Farmers and ex-farmers, it seems, are co-dependent, constantly grappling with the mixed emotions produced by living with, or having divorced, a cantankerous, consuming lover.

Sam Jr. had run a successful farm machinery business. Selling farm equipment isn't that far afield from farming, but far enough to offer, along with some independence, a degree of certainty impossible for farmers.

But then, the rewards of farmers are different, too. The single barley plant that Lykken nurtured to maturity yielded eighteen kernels. Sam Jr. said, "I distinctly remember him shelling it out at the kitchen table." Eventually, Lykken offered some of the barley he'd grown out to agronomists at the North Dakota Agricultural College, now North Dakota State University, to use for testing and breeding. When the refined barley became available to upper Midwestern farmers during the 1940s, it carried the name Kindred, Lykken's hometown.

There were four rust epidemics in the 1950s, but damage to the region's barley crop was negligible. Steffenson, the plant pathologist, explained that what made Kindred special was its "T-gene." This enabled resistance to wheat stem-rust fungus, which attacks both wheat and barley. The fungus constantly adapts to its environment and eventually overcomes a plant's defenses. But decades later, the T-gene still helps protect upper Midwestern barley varieties.

"Lykken's selection of what became Kindred barley has to be the most significant contribution to barley production in the Upper Midwest during (the 20th) century," Steffenson said. "Farmers will not obtain good

---

In the Time of *Breaking the Nations*

Thomas Hardy (1840-1928)

Only a man harrowing clods
    In a slow silent walk,
With an old horse that stumbles and nods
    Half asleep as they stalk.

Only thin smoke without flame
    From the heaps of couch grass:
Yet this will go onward the same
    Though Dynasties pass.

Yonder a maid and her wight
    Come whispering by;
War's annals will fade into night
    Ere their story die.

yields or malt quality unless there is rust protection in the varieties they grow. The savings to growers must have been in the hundreds of millions of dollars."

Lykken's contribution to his neighbors and their children who went on to farm rests on his decision to walk through a barley field that was decimated, percentagewise, a hundredfold, minus the smallest yet most significant fraction imaginable. I wasn't able to see what Lykken did, but I did watch my dad practice munificence mundanely. For example, in spring his decisions of which crops to plant were guided many times by the need of the land, not desire for more money. Having seen wind remove topsoil down to the hardpan in the 1930s, Dad always erred on the side of conservation. And so, even though a particular field had been in summer fallow the season before and had the nutrients to support a wheat crop, Dad might nonetheless decide to plant less-profitable oats, which would produce an abundance of straw, if he felt the knolls in that field could use the extra residue.

I have a small spiral-bound notebook in which Dad recorded oil changes on our tractors. At the top of one page is written, "5-3-78," two days before my 23rd birthday, and below that this entry: "All is well once more. Dean and Nicki are taking over the farm. We had a good crop last year." I often ask myself why I farmed for only two years before quitting. The reason I settle on most frequently is this: I did not inherit Dad's grit. Even if Dad was no hometown hero, he was a Lykken-style farmer.

Years after Lykken died, military technology spawned the global positioning satellite system, which now provides progressive farmers with details such as yield and fertility data. Proponents have coined a phrase: site-specific farming. But what would a GPS map of Sam Lykken's rusted-out barley field have revealed? A bulletin produced in 1999 by the North Dakota State University Extension Service begins with this sentence: "Site-specific farming is a different way of thinking about the land." When I pretend that Lykken has read that sentence, I see come to his lips a knowing smile.

One Plant, One Gene

Behind the story of Sam Lykken's artistry in the field is a mystery about plants.

Why in a wrecked field was there a lone healthy barley? How do its descendants stand up decades later, with only one significant protective gene, to a disease that would be expected to change form and overcome it within a few years?

Working with descendants of an undeveloped Swiss barley, University of Wisconsin breeder R. G. Shands had discovered resistance to stem rust. He did not, however, release a resistant variety to farmers. The breeding involved can take 15 years. But breeders work with thousands of lines, and the greatest care does not prevent an admixture from occurring during harvest and threshing. Brian Steffenson, a cereal pathologist at the University of Minnesota, said, "It is very difficult for breeders to release a variety that is absolutely pure. A released variety may also contain other lines from the breeding program that were accidentally mixed in through various handling steps."

So as little as one stray barley may have found its way into the Wisconsin 37 breed that Lykken planted, and in walking his 20-acre field, he found it. "He was a very good observer to see this."

The gene that enabled the plant's productive survival is now in all varieties of the upper Midwest, where most U.S. barley grows. Lasting over generations against a disease like stem rust usually takes the breeding of a complex pyramid of gene resistance. That is so for wheat, which also suffers stem rust and once was a larger breeding ground to infect barley. Another rust host species, the European shrub barberry, has been eradicated. But the breeds developed from the plant that Lykken found have stood up for half a century to great extent on one gene.

Steffenson recently cloned the gene and discerned how its DNA is written. Then he spliced it into a barley variety that had been susceptible to rust. The result not only resisted rust, but the naked eye could not detect the infection. "That was astounding," he said.

There are no plans to put this engineered barley into circulation. Steffenson said conventional breeding is as effective and timely, and is easier and less expensive. (See Stan Cox's "The Emperor's New Chromosomes" in *Land Report* No. 70.) But the effort proved that the resistance came from one gene.

The how remains a mystery. "This is all very new and exciting," Steffenson said.

But: "It may give us some clues as to why it's lasted so long."

—Scott Bontz

Real Homeland Security

Mary Berry Smith

I was picking tomatoes on our small farm in north-central Kentucky when I heard the news of the September 11 attacks on the World Trade Center and the Pentagon. It took me some time before I understood that what Bob Edwards of National Public Radio was talking about was not a book or movie. I was horrified and frightened when I realized what he was describing was real, but I wasn't surprised. It seems that I live waiting for the next awful thing to happen somewhere in the world.

Our farm sits near a small town in a world made up mostly of small places—places affected by the policies of their governments but seldom consulted or considered. This place has been my "homeland" all of my life, and my family's for eight generations. The government that now wants to talk about "homeland security," an obnoxious phrase, has been working at economically destroying our homeland for a good deal of that time.

Because we now know what we should have known all along—that we are vulnerable to terrorist attack—maybe we are ready to think about what a secure homeland might really mean and how country places like ours might fit into it.

In a *New York Times* article dated October 28, 2001, Neil Harl, a professor of agriculture and economics at Iowa State University, says that "The terrorists know that the surest way to bring a country to its knees is to attack the food system and water systems." The problem, the article goes on to say, is that "the food chain is nearly impossible to secure fully because of its massive scale." People should have been plenty worried about this before September 11, and they should be asking to hear some serious talk about it now. I'm asking, and I have been for 20 years. All I've heard from our leaders, elected and otherwise, is talk of hiring more food inspectors. This is ridiculous for many reasons, not the least of which is that the food inspection system is currently failing to find manure on meat, some of which can be seen with the naked eye.

Our country, through its ruinous desire for cheap food, has nearly destroyed the safest food system we could have: farmers feeding the people closest to them. Our current farm policy permits mergers, allows for concentration, favors agribusiness, and teaches that small farms can't survive, while subsidizing large farms with what amounts to welfare payments. These policies ruin the market for small, independent producers who want fair prices, not welfare. And so what has happened to America's small farmers has not been inevitable; it has been the result of policy.

The further loss of small farms is not inevitable, either. My uncle John M. Berry, a farmer and a lawyer, says that we must keep bringing these things up because we're talking about the next generation's ability to eat. He says politicians won't take up these questions because there is another election between now and then.

Which brings me back to picking tomatoes on the morning of September 11. When my husband and I bought our farm in 1981, we thought of ourselves as conventional farmers. We had a dairy, raised corn and hay to feed the dairy cows, and raised tobacco. Over the next six or seven years, it became clear that what we were doing didn't make any sense. We were working ourselves and the farm to death. And so we began a change that is ongoing. We began to ask ourselves some questions that we hadn't thought of before:

How does our place look?

Is the soil on our farm improving?

Are we keeping the areas of our farm that we're not farming, such as waterways and woodlands, healthy?

Are we including our neighborhood in our decisions about what we do here?

Are we doing something that we would be glad, and proud, to pass on to our children?

Of course, economics must be considered, and it is. My husband and I, with the help of our three daughters, raise and process pastured poultry (chickens and turkeys), and raise organic vegetables and organic beef. For the most part, we sell products directly to our customers. There is no one in the middle, and trust ensures safety and quality. Our customers trust us to provide delicious, healthy, safe food; we trust them to pay us a fair price. Along the way, many of our customers have become our friends, which is certainly an added pleasure.

Can we imagine a community, a city, a state, a nation, and finally a world running on this kind of real economy? Can we imagine little places like ours as an integral part of a secure homeland? In these days of fear and foreboding, can we not see a better way? After all, what do we need to be secure? Certainly not instructions from our President that patriotism means buying more useless stuff to keep a false economy going.

We need clean food, water and air. We need decent places to live: healthy cities and a prosperous countryside. That would be real homeland security—and a homeland worth fighting for.

Reprinted from the February issue of Chronicles *magazine.*

Welcome to Our Circle

This year we more broadly spread our word and those of the like-minded.

To reach The Land Institute's aim for ecological farming and culture healthily connected to it, there must be greater public awareness and help. So we have begun bringing together writers and distributing their essays for newspaper op-ed pages. You might call it Little Editorial Syndicate on the Prairie, but we named it the Prairie Writers Circle.

Its essays appear regularly in Kansas newspapers, from small weeklies to the largest daily, the *Wichita Eagle*. Pieces also have appeared in the *Kansas City Star*, the *Des Moines Register*, the *St. Paul Pioneer Press* and the *Denver Post*. We're still expanding our range.

That growth appears as stars on a wall map near the desk of George Pyle, former editor of and columnist for The Land Institute's hometown paper, the *Salina Journal*, and contributor to the *New York Times'* op-ed pages. Pyle writes approximately a piece a week for the Circle, and makes a lot of calls and e-mails to introduce the group to editors and send its essays. The group's other leader is Harris Rayl, the *Journal's* former publisher and current member of the newspaper's parent company board.

The Circle's Kansas contributors are leaders of environmental organizations and interested others. National members take similar ecological views but on a broader scale. A thread running through much of the commentary is the need for sustainability in agriculture and community. Topic examples include industrial agriculture and the problems it poses, water quality, soil erosion, energy efficiency, land use, habitat preservation, biotechnology, environmental politics and the relationship between the environment and human health.

But the circle spreads wider than that. Following is an example. To see all the essays as they are released, go to our web site, www.landinstitute.org. And if you see one of our pieces in your paper, we would appreciate receiving a clipping or at least notice by e-mail, at theland@landinstitute.org.

A Homestead Act for 21st Century America

Robert Day

I have an idea. How about we repopulate the rural areas of America with poets and painters and scholars? And oboe players who want to practice in the solitude of the High Plains?

My thinking is that we get a Rich Somebody's Foundation to buy up semi-ghost towns with the idea of repairing the abandoned houses, cleaning the lots, turning on the street lights, and then inviting a sonnet writer from Brooklyn to Petrarch away in peace for a few months with a morning coffee pot perking in the kitchen and coyotes howling at the edge of town at night. It would do both the town and the poet good.

What's so funny?

My wife and I live like this. She's a painter working with glee and oils in a rebuilt chicken shed we had pulled onto our property in Bly, Kansas. There is no Bly, Kansas. I'm not going to tell you where we live. Only that we live in a town like Bly. A lovely, more than half-abandoned town on the High Plains with wild turkeys walking West Dirt Street and dove roosts in the cottonwood trees.

We've got fine neighbors. Do they think we're strange because my wife doesn't make paintings of windmills and that I don't write cowboy poetry for Hallmark Cards—much less run cattle for a living? Yup. Do they like us and help us? Our neighbors are the ones who set up my wife's chicken shed. It's been great fun.

By my counting there are half a dozen houses in Bly that could be bought and repaired. Maybe more if you add the ones that aren't for sale but are falling down and might be for sale if you could find the owner. And there might be 10 lots or so onto which you could move in houses from the country.

What the Rich Somebody's Foundation does is buy these properties and hire local contractors to put them in good shape. Then the foundation establishes a trust run by the local banks, and the trust pays for the upkeep of the houses. It wouldn't be much over the years. Oboe players don't do much damage to property.

When it is all settled about the money and the trust, and when the windows of the houses are washed and the floors swept clean, and the squirrels and the pack rats

have been run out of the attics, you print a Homestead flier for the rest of America.

Free House In Kansas.

But not free to everybody. And not free forever.

I imagine a scholar who needs six months to finish a book on Carrie Nation that is difficult to write because there's no place in his high rise to walk between paragraphs. Writers need a place to walk between paragraphs. Montaigne says his mind was never busy unless his feet were. We've got paragraph breaks all over Bly.

I imagine a potter who arrives from Denver one spring morning with a load of wheels, a kiln and buckets of clay, and by the next day you can hear the wheel spinning as you walk down Middle Dirt between paragraphs. Then a few days later in the Bly Co-op on the edge of town (where the Committee to Save the World meets over coffee) they are talking:

"Did you see we got ourselves a woman potter this time?"

"My favorite was the bagpipe player."

"Is it true she'd play her bagpipes all by her lonesome down the creek where Cody keeps his goats?"

"It is."

"I liked the poet. He didn't seem to do anything but he didn't brag about it."

"Cody claims the music was good for his goats."

What's so funny?

I imagine my wife in her chicken shed looking out the windows to the south, where she can see rows of pots being set out in the October sunshine by a woman from Denver who has done lovely work over the summer and who, later in the day, will make the rounds here in Bly to thank everybody for how kind they have been, and invite them over to see the pots, and to pick one for themselves as a gift for their kindness. And we will all gather together and tell stories about the bagpipe player and how her music was good for Cody's goats.

I like my idea.

Above: Richard Crowson/Wichita Eagle

The Land Institute Annual Report

Each of our programs is intended to increase the likelihood that our society will improve the ecological sustainability of our food supply. Natural Systems Agriculture is an original concept, one that requires perhaps 25 years and a large investment to develop. However, there seem to be no other programs to achieve such an integrated range of improvements. Our other programs and frequent presentations in public forums build a constituency and acceptance of new ideas for agriculture. Food should be a vital topic to everyone, since we all eat.

Natural Systems Agriculture proposes farming that behaves more like a natural ecosystem than do the single-crop fields of annual plants that humans have grown since their beginning as cultivators. The tragedy of agriculture has been and remains the relentless loss of topsoil. We throw away the virtually irreplaceable material on which land life depends. We choke our rivers with the soil itself, which also carries heavy loads of chemicals meant to fertilize and manage pests and diseases, but which run off to poison streams and kill all life in large areas of oceans. Agriculture is undercutting the very basis of our sustenance.

NSA proposes that fields now in annual grains, which produce 70 percent of the world's calories, could instead mimic the integrity of local natural ecosystems. In our case that will be "domestic prairie." NSA is based on ecological principles and will apply to ecosystems worldwide, but we start with the prairie because it is where we are and because the payoff in calories is so high. The prairie mixes perennial species that sprout from established, deep webs of roots. The prairie holds soil, provides its own fertility, runs on sunlight, efficiently manages rainfall, and is not plagued by weeds or epidemics of pests or diseases. How can we fashion an agriculture with the same benefits? We need perennial crop plants and techniques for growing them in mixtures. That brings us to our current research.

This is the third year we report progress on perennializing major crops. Few if any efforts have yielded as many hybrids from annual and perennial parents over a single greenhouse season as our cool-season breeding program did in 2001-02. Cool-season grasses include wheat, rye and related species. We obtained more than 1,500 hybrid offspring from crosses involving four

Scott Bontz. From left, Sheila Cox, Trevor Davis and Matt Bakker, summer workers at The Land Institute, cut and bind rye. A German breeder developed this perennial rye for forage and grain. We are growing large populations in an attempt to find families that can survive Kansas' summers, which are hotter than in Germany and in Oregon, where the plant also has been grown.

annual and eight perennial species. We used diverse parent plants in these crosses to build genetic variety in each species for future breeding.

As spring approached, emphasis moved to warm-weather species: sorghum, sunflower, and perennial legumes. Our perennial sorghum program received a major boost this spring when more than 100 hybrid plants that survived the winter began to regrow vigorously. More than 5,000 offspring of these proven perennial plants have been established. We are evaluating seed collections of the perennial Maximilian sunflower to choose parents for crosses with the cultivated annual sunflower. The native Illinois bundleflower from our own and other seed banks has been sown for field evaluation to select the best breeding parents.

Agroecology research included our second harvest from an experimental step toward perennial polyculture, intercropping of wheat and alfalfa. We need to learn how the nitrogen derived from alfalfa can best be made available to the wheat.

Above: Joan Olsen. In the foreground is native prairie, the model for the agriculture being developed by The Land Institute. In the bottomland below are plots of wheat intercropped with alfalfa, an experimental step toward growing mixtures of perennial grain crop plants, including legumes to build nitrogen.

In February, we began water and nutrient studies of a native prairie on fertile bottomland. We analyzed soil for organic matter, nitrogen, phosphorus, potassium, nitrate- and ammonium-nitrogen, and texture. Throughout the growing season we will monitor soil moisture. In addition, we are studying perennial and annual root systems and the ecology of beneficial soil fungi, and conducting long-term agroecological trials.

"Breeding Perennial Grain Crops," by chief scientist Stan Cox and others, analyzes the opportunities for perennializing grain crops. It was published this year in *Critical Reviews in Plant Sciences*, rated fourth in "impact" among 110 plant science journals.

Two new staff members brought our researchers to eight, quickening the pace. Cox calls the plant breeders his "dream team."

Acreages at the Sunshine Farm, between the office and the classroom and along the Smoky Hill River have moved into active research use. There are breeding plots, diverse collections of wild perennials and agroecology plantings.

We expanded the chamber used to simulate winter chill for plant development and built a new cool room in the greenhouse to breed wheat with grasses that need very cool weather during pollination. We expanded the use of the greenhouse overall. An extension on the north side with shade cloth ceiling and walls will carry safely through the summer 1,500 pots of new, valuable hybrids. We acquired a new tractor to plant and cultivate

Scott Bontz. We obtained a new small tractor for working small experimental plots. Our farm manager, John Mai, converted a horse-drawn cultivator to use with it. Here he drives the tractor while plant breeder Lee DeHaan muscles the cultivator to weed perennial rye.

small breeding plots, and to use with it adapted an old horse-drawn cultivator.

Graduate Research Fellows are helping conduct research for our agenda, two directly with experiments here, and others at universities. There are eight new and five renewed fellows. All attend a weeklong workshop each year.

The Sunshine Farm, after a one-year feasibility study, completed nine years of field work and data accumulation in December. This project will produce data and analysis to inform policy-makers on the energetics of farming as they work to increase ecological sustainability. It will also serve to compare current agricultural practices with alternatives such as NSA.

Publications this year included a cover story in *American Journal of Alternative Agriculture* that examined Amish draft-horse farming, including its cropland requirements compared with that of ethanol tractors. "Energy in Agriculture and Society" appeared in our summer 2001 *Land Report* and will make its way into a book about the Sunshine Farm. Five other papers are in process: animal production in current and 1920 agriculture, comparison of the energetics of draft horses and biodiesel tractors, the lifetime energy budget for solar energy panels, accounting boundaries and energetics of a cow-calf beef operation, and the energetics of an organic farm's establishment and operation.

The Prairie Writers Circle is a new program aimed to promote awareness of how agriculture, politics, culture, and the natural world affect each other. We do this by providing a stream of op-ed pieces free to newspapers. After the first six months, we have about 40 participating writers and about 75 clippings to show for it. For more about the Circle, and an example of the writing, see page 20. To see all essays as they are released, go to our web site, www.landinstitute.org.

Thank you to our contributors, January through June 2002

The time span in the headline for the previous issue's list should have said October through December 2001. We apologize for the error.

Individuals

A
Mary Ragan Adams and Franklyn Garry
Paul Adelman and Kate Girard
Janet E. and Carl E. Andersen
Angela A. Anderson
Professor Richard E. Andrus
Anonymous
Anonymous estate gift
Robert J. Antonio
John M. Armstrong
Vanessa Arn
Jennifer Atlee
Patricia A. and Tim C. Ault-Duell

B
Juanita R. Bachmann
Sydney and Raymond B. Backstrom
Mr. Amos G. Baehr
Walter T. and Virginia A. Bagley
Sarah Joan Baker
Jeri D. Baldwin
Robert Bangerter
Andrew S. Barker and Ana Ruesink
Jean E. Barker and Paul D. Burks
Professor Theodore M. and Mary P. Barkley
William G. and Roberta L. Barnes
Robert C. and Charlotte Baron
Michael D. and Pamela S. Barrett
Robert C. Barrett and Linda E. Atkinson
Douglas E. Bartlett and Claire Twose
Ruth D. Basney
Eugene J. Bazan
W. Conger Beasley Jr.
Paul and Susan Bedell
Rich and Katie Beilfuss
Kirk and Debra L. Benton
C. Wendell and Betty Berggren
Judith Bergquist and James Trewitt
Alan R. and Miriam Straus Berkowitz
Luther and Helen Berntson
Thomas W. Berry
Martha A. Bieri
Patricia E. Bieze
Erika A. Binns
Aaron and June E. Blair
Steven N. and Jane P. Blair
Dorothy H. and Harry Bloom
Ross and Lorena Blount
Charles R. and Dianne E. Boardman
Egon and Diana Bodtker
Patrick J. Bohlen and Julie Mitchell
James Bond
Bruce D. and Marcia M. Bonta
William G. F. Botzow II
Cliff Bradley and Rita Jankowski-Bradley
Nina L. Bradley
Dr. Dennis M. and Jean C. Bramble
George H. and Elizabeth B. Bramhall
Shirley I. and Raymond H. Brand
Edward J. Braun and Jean B. Krusi
Sheryl D. Breen
Darlene Brehm-Sexton
David M. Brenner and Anne Kimber
Joyce Brink
Bruce A. Britton, M.D.
Dr. and Mrs. Robert Brizee
Jack Brondum and Patricia McGowan
William and Susan C. Brooks
Cheryl L. Brown
Dorothy F. and Bobb F. Brown
Hugh M. and Dorothy M. Brown
Hugh J. Brown, Ph.D.
Willis E. Brown
Amadea Bruen-Morningstar and Gordon Bruen
Professor E. Charles Brummer
Charles A. and Joanne B. Bryan
Gregory W. and Susan D. Bryant
Carol G. and Stephen P. Buckels
David L. Buckner
Professor Matthew J. Buechner
Carl G. Buhse
Janet D. Bunbury
Denise Burchsted
David P. and Kathryn A. Burden
Bill Burgdorf
Collette Burke
Megumi Burr
Steve and Ginny Burr
Dr. Michael Burton
Jerry D. Busch
J. Walker Butin
John B. and Eleanor S. Butler
Brad Byers
Catherine Bylinowski
Anne Simpson and Paul S. Byrne
James P. Byun

C
John and Kay N. Callison
Doug and Janine Calsbeek
Andrew W. and Lisa M. Cameron
Dr. Bruce Carlson
Bryan Jon Carlson
Jim and Carressa Carlstedt
Meri Carlstedt
Norman M. Carr
Dale M. Carter, M.D.
William P. and Kristine Casey
James P. and Marianne G. Cassidy
Suzanne Casson
Lorna W. and D. Douglas Caulkins
Mr. and Mrs. John A. Chaffin
Norman R. Chaney
Barry Chapman and Jessie P. Norris
Hal S. and Avril L. Chase
Jonathan and Jeanmarie Chenette
Kelly D. Cherrey
Jane C. and Buck T. Childers
Wayne A. and Judith M. Christiansen
Barry Christianson
Kenneth Church
Katherine L. Clancy
Sharon A. Clancy
Regina Clark
David M. and Debra J. Cloutier
Michael R. Clow
David C. and Frances E. Coleman
Lee W. Collinsworth
Dr. Brian E. and Ann Conner
Dr. J. Lea Converse and Dr. Paul Lessard
James Cooke
Maren Leyla Cooke and Neil M. Donahue
Richard E. and Anne E. Courter
John and Sage Cowles
Marc A. Craddock
William J. Craig
Kenneth L. Cramer
Robert A. and Barbara W. Creighton
William E. and Ann H. Crews
Elizabeth A. Crisfield
David S. and Kim Criswell
Pamela Deanne Cubbage
Cynthia Curlee and Robert C. Camp
Paul Currier
William C. Cutler and Elisabeth Suter

D
Francesca D'Anneo
Mark and Bernice D'Souza
Professor Gretchen C. Daily
Helen Davis
Dr. William D. and Kristine B. Davis
Jordan and Gail Dawn
Peter R. Day
Patrick L. and Susan E. Dean
Virgil W. and Jan Dean
Wesley F. and Verda G. DeCoursey
Sabino L. and Janice C. DeGisi
Susan B. Delattre
Erin Deller
Diane Dempster
Joe R. Des Jardins
Al and Mary H. DeSena
Joseph E. and Jacqueline M. Detelj
Edward G. Di Bella
Martha Dickinson
Steve Dinneen
Robert M. Dixon
Fred and Arlene Dolgon
Brian Donahue and Faith B. Rand
Thomas M. and Esther M. Donahue
Andrea F. Donlon
William A. and Pat L. Dorman
Alan R. Drengson and Victoria Stevens
Merlin D. and Sandra K. Dresher
James F. and Mary N. Dudley
Eileen Duggan
Fred Y. Durrance
Peter K. Duval

E
Betty H. and David J. Edwards
Stefan C. and Margaret E. Smith Einarson
William L. and Helen Elkins
Eldon L. and Susan G. Elmore
Jean A. Emmons
Richard Todd and Kimberly Kelling Engstrom
Loren A. and Donna L. Entz
Anne Epstein
James P. Erickson
Marjorie Lakin Erickson and Wesley Roe
Eldon E. Esau and Janice L. Regier
Robert G. Esbjornson
Claryce Lee Evans
Terry and Sam Evans
Michael Ewanciw

F
Ole Faergeman, M.D.
Laura L. Falduto
David L. and Patricia L. Fancher
Eric Farnsworth
Charles S. Faulkner II
Sean L. Feder
Betsy B. Fehsenfeld
Douglass T. Fell
Sky Feller
Christian G. Fellner
Pete Ferrell
Richard A. and Miriam L. Ferrell
Donna L. Feudner
David D. and Judith R. Finley
Margaret M. and William J. Fischang
Rob and Julie Fischer
Kathleen Fisher
Mary E. and Robert Flickinger
Christopher and Elizabeth Flinchpaugh
Laurence B. Flood
Jan and Cornelia Flora
A. Anne Focke
Kent and Beth Regier Foerster
Ronald C. Force
J. Thomas Ford
Dana K. Foster
Nicolas T. and Gisela Franceschelli
Charles A. and Barbara L. Francis
Madeline L. Frankel and Jay H. Pressman
John K. Franson
Barbara A. Frase
Mr. and Mrs. Edward C. Frederick
Ms. Rachel R. Freifelder
Jean W. French and Ben Fischler
Stan and Jane Freyenberger
Thomas A. and Polly A. Fry
Cyril R. and Donna B. Funk

G
John W. and Judith M. Gallman
Royal S. and Karen E. Garner
David Gates and Diane Gumz
Larry Gates and Peggy Thomas
Jane A. Gauss
Mavis M. and George M. Gehant
Jared N. and Cindi M. Gellert
Carolyn Cox George
Elisabeth Gibans
Timothy C. Gibbs
Sarah and Joseph Giffen-Hunter
Mark O. and Pat Gilbertson
Michael A. and Karma E. Glos
Ernest J. and Mary Lou Goertzen
James P. and Rebecca A. Goodman
Robert K. Gordon III and Mary K. Sullivan
Nils R. Gore and Shannon R. Criss
John Emmet and Margery Graves
Marion W. and Esther N. Gray
Robin and John McClure Greenler
Gregg T. Greiner, D.V.M.
Charles G. and Patricia A. Grimwood
Ms. Marion B. Griswold
Jeffery E. and Therese Erickson Grumley
James L. and Nancy K. Gulley
Phyllis L. Gunn

H
Charles Haffner III
James L. and Karen J. Hamrick
Eldon and Margaret Handrich
Don and Nathalie Hanhardt
Lloyd B. Hansen
Dr. and Mrs. Garrett Hardin
Benjamin and Lucy Bardo Harms
Duane K. Harms
Cheryl Harrington Harper
John Hart and Jane Morell-Hart
Peter G. and Mary Jean Hartel
William Hawley
Lois F. and Charles M. Hayes

Above: Peter Goin.
Shadow figure looking
east, Merriam Point,
Crater Lake, Oregon.

Peter Ridgaway Hegeman and Patricia Egan
Warren J. and Rosemary A. Heidrick
Lauren Heine, Ph.D.
Professor Nicholas and Suzanne W. Helburn
James F. Henson
Dr. Robert A. Herendeen
Eric and Mary Herminghausen
Michael T. Hernke
Erik S. and Lea Marie B. Herron
Frederick T. Hill III
J. David Hill and Martha Cooper
Stephen H. and Marcia Hannon Hill
Mr. William McLin Hill and Laura Selleck
Sarah Jack Hinners
David L. Hodges and Elizabeth Knight
Ruth C. Hodges
Dr. Stanton F. and Carol Hoegerman
Kurt Hoelting and Sally Goodwin, M.D.
Craig and Henrike Holdrege
John M. and Catrinka Holland
Margaret A. Holm and Keith L. Rader
Nancy Holt
Wayne Hongsermeier
Ernst Horber
Mark L. and Linda K. Howard
Charles F. Howe
Jerold and Bonnie Hubbard
Darrell K. and Bunny E. Huddleston
Jean E. Hulbert
Dean and Nicki Jo Hulse
Jon C. and Audrey F. Hunstock
William Hurrle
Linda S. and Terry A. Hurst
Brian T. Huston and Evelyn R. Anemaet

I

Dr. Gilford J. and Nelda B. Ikenberry
Hunter Ingalls and Mary Emeny
Charles and Dominique Inge
Jean S. Ingold
Priscilla G. Inkpen

J

Harley T. and Linnea Jackson
Gordon and Lois E. Jacobson
M. Allen Jacobson
Ronald A. and Grace Jager
Craig Jagger and Joy L. Harwood
Jean-Luc Jannink
James L. Janzen and Carol Knieriem
Kristi Bahrenburg and Bernd Janzen
Dorcie McKniff Jasperse
Lawrence and Mildred Jensen
Kenneth D. and Wilma F. Johnsen
Charles Aaron Johnson
Eric R. Johnson and Michele Roesch-Johnson
Larry L. and Pamela J. Johnson
Grace Elizabeth Jones
Lucy Jordan
Dr. and Mrs. Charles R. Jorgensen

K

Al Kammerer and Sue Maher
Jennifer Kane
Dr. Patrick C. Kangas
Klaus G. Karbaumer
Dr. Michael G. and Shawna Lea Karl
Tim and Sharon Keane
Dr. Carl S. and Gladys E. Keener
Gretchen Ann Kehrberg
Robert G. and Judith Kelly
Alissa and Neal Keny-Guyer
Kenneth J. and Sue K. Kerchenfaut
Lincoln Kern
Todd Kimm
Kelly Kindscher
James L. Kirkland Jr.
Jay C. Klemme and Anne S. Wilson
Mark C. Klett
Paula Kline and Alan J. Wright
Don Kluever
Raymond C. and Marianne D. Kluever
David Andrew Knapp and Robert C. Freese
Edwin H. Knittle
Kirvin L. Knox
Ulrich Koester and Beth Kautz

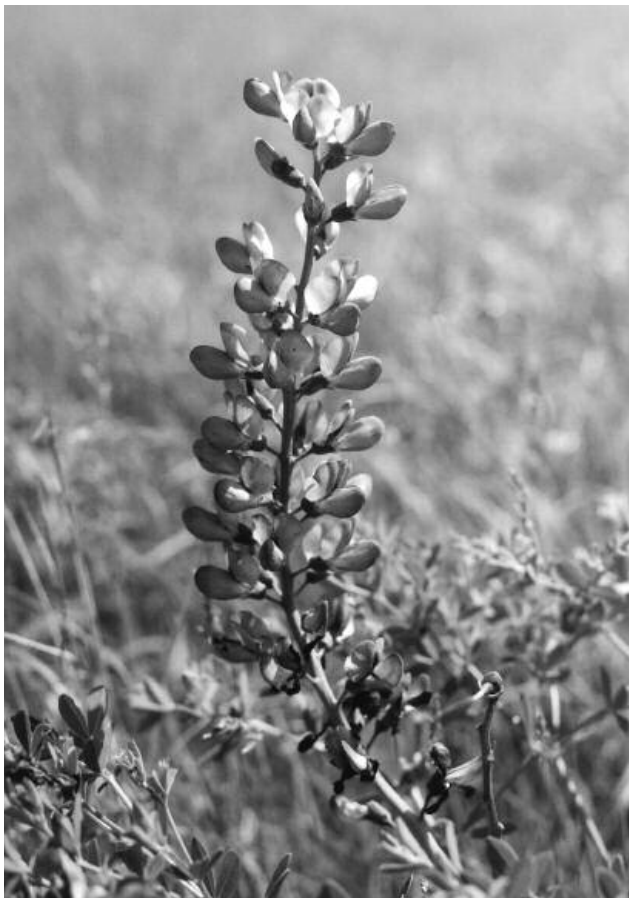
Sharon A. Konen
Walter J. and Barbara J. Koop
James Koplin
Nic and Mary Korte
Douglas A. and Patricia A. Kramer
Simon M. Kras
J. Stuart and Barbara N. Krebs
Kathleen Krehbiel-Boutis and Nikos Boutis
David J. and Heidi R. Kreider
Keith W. Krieger
Ronald A. Kroese and Kimberly Colburn
John E. Krogsrud
Alan L. and Marti Kruckemyer
Robert J. Krumhansl
Stanley V. and Lois G. Kruschwitz
Nelda B. Kubat
Keith A. and Marian J. Kuper

L

Mark and Robin Lacey
Milan Lambertson
Randall J. Larrimore
Mark C. Larson and Mary B. Kennedy
Mark Larson
John E. and Marcia J. Laubach
Eulah C. Laucks
George W. Lawrence
Winfred M. Leaf
Carla A. Bouska Lee
Mary L. Lehmann
Ron Lehmkuhl and Idalia T. Mantautas
Daphne B. Lewis
Lawrence B. and Ruth G. Lewis
Paul E. and Lynn Days Lewis
Matthew Z. Liebman and Laura C. Merrick
Wendy Liles and Mark Norem
Janice E. Lilly and Cary A. Buzzelli
Nancy R. Lindbloom
Mark S. Lindquist and Kristine Schlangen-Lindquist
Donald N. and Nancy Link
Martin J. Link
Lucy R. Lippard
Gerald D. and Janice Lockhart
Gary A. and Judy A. Lohmeyer
Robert and Janet London
Jonne A. Long
Sandra B. Lubarsky and Marcus P. Ford
Dr. Daniel B. Luten Jr.
Zach J. and Casey Crawford Lynch
Sandra D. Lynn

M

Michelle C. Mack and Edward Ted Schuur
Chuck and Joey Magerl
Audrey Magoun and Patrick Valkenburg
Susanne L. and Walter J. Maier
Gordon M. Mallett
Grant W. Mallett and Nancy Tilson-Mallett
James R. and Nanette M. Manhart
Michael F. Maniates and Kathleen M. Greely
Dr. Frances R. and Margaret P. Manlove
Ryan Marlinghaus
Robert B. and Nancy Lehenbauer Marshall
Ms. A. Charlene B. Martin
Christopher S. Martin
David E. Martin
Francis G. and Christine B. Martin
Michael Paul and Minnie Sweeden Martin



Memorials

Arnold Bodtker
from Egon Bodtker
Mr. and Mrs. Burke
from Julien Y. Perrette
Fred H. Gerdes
from Mae Thomas
Walter Givans
from Kirvin Knox
Avenell R. Harms
from Duane K. Harms
Marion Jean Johnson
from Charles A. Johnson
Mark and Katie McManus
from Richard
and Marjorie McManus
George Peden
from Alicia L. Peden
Gale Warner and Jack Warner
from Louise Warner
and Clyde Gosnell
Georgia A. Weber
from Carla A. Bouska Lee

Honorary gifts

Jori Bieze
from Pat Bieze
Carol Brown
from Dorothy and Hugh Brown
Ms. Jeanne DeHaemers
from Lenton
and Norma Jean Roller
The Dudleys
David Wheaton
from Kathleen Fisher
David Engelken and Tricia Huth
from Celeste Rossmiller
John G. Gallman
from John W.
and Judith M. Gallman
Dennis Michele Koski
from Dorothy McNeil
Ben Pressman
from Madeline Frankel
and Jay Pressman
The Sheldon Family—Bill, Cindy, Tyler and Katie
from Michele and Bill Obermeier
John Simpson
from Anne Simpson Byrne
and Chip Byrne

David Martinez
James and Sarah Mason
Ernest L. and Kathy M. Massoth
Thomas R. and Nina L. Mastick
William and Robin B. Matthews
Matthew L. Mayers
Elizabeth T. Maynard
James L. and Katherine A. Maynard
William A. McBride and Julia Fabris
Mary Gayle McCall
Clinton and Cyndia McClanahan
Callie McConnell
Marion McConnell
Steve McConnell
Lane and Janet M. McDonald
Jeff McFadden
Alberta J. McGrath
Jocelyne O. and Casey E. McGreever
Richard P. and Marjorie T. McManus
Victoria M. McMillan
Dorothy F. McNeil
Larry E. McPherson
David B. and Susan Kay Mengel
Karl Meyer
Sara Michl
Howard Walter Mielke
Jeanette and Mark Mikinski
Gerald E. Mikkelson
T. H. and Kathleen M. Milby
John C. Miller and Sandra Bot-Miller
Kim and Dianne E. Miller
Margaret J. and Paul A. Miller
Philip T. and Kathlyn Miller
Thomas A. and Zora E. Milne
Robert A. Mischka
Grover C. Mitchell and Harriet G. Hodges
Joanna M. and Stephen C. Mitchell
Julie E. Mitchell
Suzanne Meyer Mittenthal
Bonny A. Moellenbrock and Michael I. Lowry
Judith A. Mohling
Jeffrey L. Moline
Robert T. and Kay L. Moline
Lowell and Julie Monke
Thomas W. and Anne H. T. Moore
H. Stewart and Joyce Moredock
The Rev. Kathryn L. R. Morrison
Lynn W. Moser
Kirsten Mowrey
Barbara L. Mueller
Jon R. and Teri Jill Mullen
Patrick M. and Sunny K. Murphy
John R. Myer

N

Hiromichi Nagashima
Karen Owsley Nease
Thomas R. Neet Jr.
Frank Neitzert
William D. and Dorothy M. Nelligan
Arthur K. and Connie S. Neuburger
Jean G. Nicholas
J. Clyde and Martha Nichols
Wendell K. and Waitstill B. Nickell
Galen R. and Rudene G. Niedenthal
Dale and Sonya Nimrod
Douglas Nopar and JoAnn Thomas
James C. Nore
David A. and Janice L. Norlin
Andrea S. Norris
Karl S. and Jane B. North
Richard B. and Elizabeth B. Norton

O

Michele and Bill Obermeier
David J. and Jeanne K. Ode
Norm Oeding
Michael and Kathleen J. Oldfather
Renzo M. Olguin
Lawrence Olsen
Stephen H. and Susan P. Olsen
Maurice E. Olson
David and Ellen Ostheller
Brad M. Ostrander
Richard and Christine Ouren
Glenn Owens
Jim and Katie Owens
Owen D. Owens

P

Jerry C. and Carole Packard
Bruce J. Palmer
Herbert Panko
David and Nurya Love Parish
Patrick P. Parke
Donald G. Parker
Karl E. and Elizabeth R. Parker

Above: Peter Goin. Eared grebe nest, Goose Lake, Stillwater Wildlife Refuge.

Dr. Kelly A. and Sandy Parker
Mary Thorpe Parker
Peter A. and Sarah Bremer Parks
Harold D. and Dorothy M. Parman
Jack Parr
Wanda Crosby Parsons
Nancy and Elam Peachey
Jeni L. and Richard J. Pearce
Kenneth V. and Ana M. Pecota
Alicia L. Peden
Charles G. and Joyce H. Pederson
Leo Pedretti
Dr. Gregory K. Penniston
Dale Perkins
R. Abner and Kathryne Perney
Julien Yannick Perrette
Dr. Robert T. Perschel
Daniel W. Pettengill
Annette E. M. Pfannenstiel
C. Frank Phillips and Deborah K. Hawkins
Loretta Pickerell
Robert W. and Susan M. C. Pigg
Robert L. and Karen N. Pinkall
Mary Lee Plumb-Mentjes and Conrad V. Mentjes
Bryce J. and Kathleen Plunkett-Black
John A. Pollack
Dave and Betty Pollart
Alison G. Power and Alexander S. Flecker
Anne W. B. Prichard
Robert T. Priess
Dr. James A. Pritchard and Dr. Diane M. Debinski
Donna Prizgintas

R

Margaret P. and Jonathan C. Rand
Kathryn L. Hoffman and Mark Rankin
Victoria Post and George A. Ranney
Thomas L. Rauch and Joyce Borgerding
Shannon Drews Rayl
Robert H. and Agnes V. Raymond
L. David and Ann Redmon
Don T. and Barbara Reeves
Arlie and Sue Regier
Taylor Reid
Richard L. and Joyce Reinke
Lauren Rentenbach and Dan Hunt
David A. Rettele and Janice K. Baldwin
Martha Rhea
J. Benton and Doris C. Rhoades
David C. and Jane S. Richardson
Randolph E. Richardson
Roger M. Richter
Curtis C. Ridling
Carrie and Danny Riggs
Janice M. and Hugh D. Riordan
Gordon T. and Barbara A. Risk
Carol I. and James R. Ritter
Barbara C. Robison
John A. Rogers
Brian Rohter
Lenton D. and Norma Jean Roller
Adam W. Rome and Robin G. Schulze
David Rosenthal
Celeste J. Rossmiller
Kathryn Rougle
James A. Rousmaniere Jr. and Sharon Ostow
Robert B. and Peggy Rover
Thomas Ruppert and Maria Carolina Gomez
Robert E. and Ann Adams Russell
Michael P. and Regula Russelle
Patricia J. and Jerry D. Ryan

S

Jennifer M. and Mark E. Sabo
John F. Samson
Scott Russell and Ruth Ann Sanders
Andrew P. and Patty J. Sargent
Robert C. Sargent
Donald T. and Susan G. Sauter
E. Wayne Say
Kathleen Sayce and Frank Wolfe
Thomas M. and Mary L. Scanlan
Richard A. and Dorothy T. Scherer
Don Schlick
A. Anne Schmidt
Karen Schnabel
Steffen A. and Rachel Schneider
Richard and Sharon Schoech

Ben J. Schole
Claire Lynn Schosser
Jeffrey T. and Lisa Spoelhof Schra
John H. Schwartz, M.D. and Linda Boochever
Cindy J. and Stephen Scott
Karl Seeley
Kim J. and Ann B. Seeley
Ruth E. Seiberling
Raymond F. and Mary C. Sell
Gerald L. and Jean L. Selzer
Jan P. Sendzimir and Gisela Bosch
Carolyn L. Servid and Dorik V. Mechau
Stephen J. and Jeannette P. Shawl
Florence R. Shepard
Steve Kent Shore
M. Susan Sievers
Anne Hawthorne Silver
Ann B. Simpson
Diane W. Simpson
Professor Charles F. Sing
Gerald C. Sipe
Mary K. Sisson and R. Douglas Ackley
Martha S. Skillman
Fred Smeds
James R. and Katherine V. Smith
Lea Smith
Margaret A. Smith and Douglas S. Alert
Dr. Robert B. and Marianne K. Smythe
Jared Snyder
David R. and Susan Burford Solenberger
J. David Soltman and Judy A. Howard
David F. W. South
Phil and Sharon Specht
John W. and MaryAnn S. Spence
James Gustave and Cameron C. Speth
Donna J. Spohn
Robert Staffanson
Eric A. and Mary Louise Stahl
Marshall P. and Janice M. Stanton
Debra M. Starin
Keith and Rebekah Starkenburg
Janie H. and Kirk N. Starr
Catherine A. Statz and Thomas J. Pamperin
Pamela C. Stearns
Michael S. and Barbara C. Steer
Robert and Clara Steffen
Jane Ann and Timothy Steger
Richard J. and Peggy Stein
Flisa Stevenson
Dennis and Mary Stewart
Eric Stewart
Margaret E. Stewart
Paul D. Stolen and Deborah K. Amazi
Jonas K. and Judith H. Stoltzfus
Janice S. and Randall J. Stone
Bianca Storlazzi
Gail E. Stratton
Charlotte M. and John G. Strecker-Baseler
Professor Richard C. Strohman
John Carl and Virginia A. Stuhr
Donald D. Stull
January Suczynski
Janet L. Suelter
Harold Supernaw
Anna A. Suter
Gerald R. Swafford
Connie S. Swan
A. J. Swanson
David K. and Shelli A. Swanson
Mr. Kris A. Swanson
Toby Symington

T

Cynthia A. Taylor and Luis A. Bravo
George H. Taylor and S. Candice Hoke
James E. and Betty L. Taylor
Gary E. Tegtmeier
Maurice and Jeannine Telleen
Alan R. and Bonnie A. Templeton
Dr. Edward H. Tenner
John T. Theisen
Robert B. and Nelda R. Thelin
Mae Thomas
John W. Thompson
Margo Thompson
Craig D. Thomsen
Brian Tomasik
Amy L. Tomson
Richard and Marney Toole
Andre and Ruth Anne Toth
Charles J. Transue
Patricia A. Traxler and Patrick Wallerius
R. Klaus and Gail A. Trenary
Lois A. Trump
B. C. Tsiknas

U

Virginia L. Usher

V

Daniel G. and Amber D. Vallotton
Susan Van Atta
Bettina H. Vandewater
Dan Vega
Sidney L. Vetter
Valerie M. and Roger R. Vetter
Eve Vogel
Keith M. Vogelsang
Robert L. and Sonia Vogl
Hank and Linda M. Vogt
Verlon K. and Elaine J. Vrana

W

Etta L. Walker
Sherry L.N. and Luke Walker
Mary E. Walsh
Christel and Manfred A. Walter
Richard T. and Barbara R. Ward
Allison L. Warner
Dr. Louise O. Warner and Clyde Gosnell
Nancy E. Warner, M.D.
Dorothy F. Warren
Deborah R. and David M. Watson
Linda and Robert Watson
Rev. J. Will Wauters and Ana Guerra-Wauters
Richard S. Waxman
Kenneth G. and Dorothy L. Weaber
Msgr. John George Weber
Wallace N. Weber
Robert B. and Judith S. Weeden
Maure L. and Theresa J. Weigel
Professor Ray R. Weil
Suzanne R. and Frederic D. Weinstein
Georgette M. Weir
Kenneth M. and Anne Buchanan Weiss
James M. Wellman
Darrell G. and Lois I. Wells
Robert Claire Wemer
Howard B. and Dorothy Westley
Jan L. Wheeler
Valerie Wheeler and Peter Esainko
Katie White
Jo M. and Stephen R. Whited
Karen K. Wilken
Roslyn Willett
Heather Williams
Richard K. and Diana D. Williams
Stanley Paul Williams
Uzelle Williams
Dan and Dayna L. Williams-Capone
Robert and Delores Willms
David N. and Barbara A. Wilson
Sarah B. Woellhof
Joyce A. and Ronald J. Wolf
Melissa Wolfe
Joel and Joan G. Woodhull
Parker and Lillian H. Worley
Catherine A. Worster
Richard H. and Sherrill Worthen
Angus Wright
David Wristen
Marjorie G. Wyler

Y

Robert J. and Janet C. Yinger
David A. and Carole A. Yoho
David A. Yudkin and Jeana S. Edelman

Z

David E. and Linda M. Zahrt
Elisabeth Zall
Ruth R. and Mark W. Zalonis
Kirsten L. Zerger and Sanford N. Nathan
Dr. Dewey K. Ziegler
Mrs. Anne Zinsser
Richard M. Zukowski and Susan Bryan

Organizations

Acme Construction
AdFarm
Affleck Acres, Inc.
Arrow Printing Co.
Aspen Business Center Foundation
Axland Golf, Inc.
Charles Benjamin Inc.
Bennington State Bank
Brethren Foundation, Inc.
Center for Design Studies
Central Care, P.A.
Central Colorado Educational Trust
Chilean Forests Preservation Fund
Design Craftsmen
Earth Mamas
East Heights United Methodist Church
Ecological Services
Educational Foundation of America
Fort Hays State University
SuEllen and Harvey Fried Family Fund
William & Flora Hewlett Foundation
Hibbard Family Trust
Hollomon Price Foundation
Hot Lips Pizza, Inc.
I & G Charitable Foundation
Kansas Health Foundation
J. M. Kaplan Fund, Inc.
KI Knosumenteninfo AG
Kinnickinnic Realty Co.
The Landscape Studio
Leopold Center
Marianist Novitiate Mount St. John
Mason Family Foundation
Oak Lodge Foundation
Dennis A. O'Toole Family Foundation
Prime-Medica Ltd.
Raney Properties L.P.
Price R. & Flora A. Reid Foundation
Roxbury Farm
R. Rubin Family Foundation Inc.
Rural School and Community Trust
Share-It-Now Foundation
Simpson Foundation
Sinsinawa Dominicans
Soil Technologies Corp.
SSER
St. Joseph Foundation
Sustainable Farming Association of Minnesota
Three Sigma Fund of Tides Foundation
Turner Foundation, Inc.
Turtle Foundation
Windy Hills Farm
Woodstock Foundation Inc.
Work Family Estate Trust

The Writers and Photographers

Robert Day wrote the novel *The Last Cattle Drive* and *Speaking French in Kansas*, a short-story collection. He teaches at Washington College in Chestertown, Maryland. Peter Goin is professor of art at the University of Nevada, Reno. His most recent book is *A Doubtful River*. Dean Hulse still owns the family farm in North Dakota where he grew up, and now is a writer living in Fargo. Christopher Picone studies soil fungi for The Land Institute. He is moving on to teach ecology at Warren Wilson College in North Carolina. Mary Berry Smith lives and farms in New Castle, Kentucky. Sharon Stewart is a cultural landscape photographer in Chacon, New Mexico, working on a village life portrait of El Cerrito since 1992. Douglas Towne, a 1988 Land Institute intern, is a groundwater hydrologist and neon sign artist in Phoenix. Donald Worster is the Joyce and Elizabeth Hall distinguished professor of American history at the University of Kansas and serves on The Land Institute's board of directors. He wrote *A River Running West: The Life of John Wesley Powell*.

Prairie Festival: Future Harvest—Fatal or Otherwise?

Wes Jackson

Rachel Carson's *Silent Spring* launched the modern environmental movement in 1962. Before this landmark book appeared, environmentalists' emphasis was conservation and wilderness its poster boy. Since *Silent Spring*, we became increasingly aware that more than pandas and condors are under siege. More recently we see biodiversity and agriculture colliding faster than ever with no simple solutions in sight, no "low-hanging fruit," no relevant "win-win" situations.

Forty years after *Silent Spring* comes the new coffee table book *Fatal Harvest*, made possible by one of our major benefactors, the Foundation for Deep Ecology, and edited by Andrew Kimbrell. *Fatal Harvest* features several authors, all addressing the problems in agriculture exacerbated during the 40 years since *Silent Spring*. Three of those authors will speak at our Prairie Festival, September 21-22.

I am going to talk, too. I will mention another book published in 1962, Thomas S. Kuhn's *The Structure of Scientific Revolutions*. This also was a landmark, in that it brought the word "paradigm" into common usage. (Unfortunately, the term was cheapened, too often applied to trivial phenomena.) Kuhn described how an older paradigm is overthrown and replaced by a different framework. Copernicus' theory of the solar system, Einstein's theory of relativity and the theory of plate tectonics are examples. I am interested in how paradigms are formed and replaced because I think our work in Natural Systems Agriculture is crucial.

We would be hard-pressed to show that any of the worldviews mentioned above improved or threatened humanity. Ptolemy's worldview, with Earth in the middle, served us pretty well. It certainly made us feel important, that everything revolved around us. None of the revolutions have spoken to the problems of soil erosion, chemical contamination of our land and water by fertilizer and pesticides, or the dependence on fossil fuels for fertility and traction.

It seems to me that we cannot afford to ignore any longer that nature's ecosystems have worked out optimum efficiencies, given the materials available. When it comes to agricultural research and production, we could ignore this reality when fewer of us were around. We could draw down the earth's stock in the interest of short-term gains derived from nature being subdued or ignored.

The two bookends of our festival, *Silent Spring* and *Fatal Harvest*, reflect the bankruptcy of the industrial mind. What we are proposing is a sufficiently different paradigm to change our worldview—eventually. Natural Systems Agriculture should be inherently compelling to farmers. Inputs for pesticides, fertilizers, fossil fuel, farm machinery and commercially grown seed will plummet. The reward will run more to the farmer and the landscape rather than to the suppliers of inputs. The incentive for researchers to solve puzzles that the industrial paradigm presents or to fiddle with the details of its phenomena is certain to decline.

These are bold words about paradigm change. Maybe I have overstated the case, but come on out and hear the speakers who, one way or another, will talk about the necessity and possibilities for change.

What's in Store

A tentative schedule is on our web site, www.landinstitute.org, and will be mailed with the invitation. Here is what we have planned: Actress Kaiulani Lee will portray *Silent Spring* author Rachel Carson in her one-woman play, *A Sense of Wonder*, followed by questions and answers, and then a discussion, led by Land Institute board Chairman Conn Nugent, of *Silent Spring's* effects. University of Michigan professor Catherine Badgley will present "The Farmer as Conservationist." Claire Cummings, a lawyer and farm editor for KPFA radio in Berkeley, California, will discuss land use. Kamyar Enshayan, of the University of Northern Iowa, will talk about linking institutional food buyers with local farmers. Margaret Mellon, a critic of genetic engineering from the Union of Concerned Scientists, will tell about pharmaceutical plants and the threat they represent. Monica Moore, co-director of Pesticide Action Network North America, will present "Getting Over Pesticides: What Does It Really Take?" There will be separate sessions with representatives of environmental groups, the Matfield Green Consortium for Place-based Education and our new Prairie Writers Circle. National Geographic photographer Jim Richardson's work will be shown. Ann Zimmerman will sing, and join caller Mike Rundle and Calliope for the barn dance, moved this year to Friday night. So, if you want an intellectual hootenanny, please come. And if you want a regular one, too, come early.

KEEP THIS PORTION FOR YOUR RECORDS – PRAIRIE FESTIVAL 2002

	Festival	Evening
Friday evening, September 20 (barn dance)	$_____	$_____
Saturday, September 21	$_____	
Saturday evening (Kaiulani Lee, "A Sense of Wonder")		$_____
Sunday, September 22	$_____	
Children under 12 register free		
Saturday evening dinner (*payable by Sept. 13*)	$_____	
Vegetarian (not vegan) meal? ____Yes ____No		
Enroll as Friend of The Land one year, tax deductible	$_____	$_____
Total Encl:	$_____	$_____

*Paid by*_____ *Date mailed, faxed or phoned to The Land Institute* _____

- *We will not confirm your registration.* • *Program, prepaid nametags and meal tickets will be available at the Registration Desk.*
- *To register with credit card via phone, call The Land Institute, Monday-Friday, 8-5pm (central time).*

The Land Institute • 2440 E. Water Well Road • Salina, KS 67401
785.823.5376 • FAX 785.823.8728 • FESTIVAL DETAILS: WWW.LANDINSTITUTE.ORG

Detach coupon below and mail to The Land Institute. Keep top portion for your records.

PRAIRIE FESTIVAL 2002 REGISTRATION

Pre-register Sat. $12/$16, Sun. $6/$8 **At Festival** Sat. $15/$20, Sun. $10/$15

You are a Friend of the Land if you have given since 9/20/01 or if you contribute with this registration.

	FRIENDS OF THE LAND	*OTHERS*
Friday evening, September 20 – barn dance only	____x $ 5 = $_____	____x $ 5 $_____
Saturday evening, September 21 – play only ("A Sense of Wonder")	____x $ 5 = $_____	____x $ 5 $_____
Saturday, September 21 (includes dance and play)	____ x $12 =$_____	____x $16 = $_____
Sunday, September 22 (includes dance and play)	____ x $ 6 =$_____	____ x $ 8 = $_____
Children under 12 register free	____ *x $ 0*	____ *x $ 0*
Saturday evening dinner (*payable by Sept. 13*) Vegetarian (not vegan) meal? ____Yes ____No	____ x $10=$_____	____ x $10= $_____
Enroll as Friend of The Land one year, tax deductible	$25 minimum $_____	$25 minimum $_____
Additional contribution to The Land Institute, tax deductible	$_____	$_____
	Total Encl: $_____	$_____

Charge ☐ *Visa* ☐ *MasterCard* ☐ *Discover*
Account # _____ *Expir Date*___/___ *Signature*_____

Names attending:_____
Street:_____City _____State_____ Zip+4_____-____
Phone (home)_____ Phone (work)_____E-mail_____

- *We will not confirm your registration.* • *Program, prepaid nametags and meal tickets will be available at the Registration Desk.*
- *To register with credit card via phone, call The Land Institute, Monday-Friday, 8-5pm (central time).* ☐ **Send map to Land Institute.**

The Land Institute • 2440 E. Water Well Road • Salina, KS 67401
785.823.5376 • Fax 785.823.8728 • Festival Details: www.LandInstitute.org

INVITATION AND REGISTRATION

Prairie Festival 2002

Future Harvest—Fatal or Otherwise?

THE LAND INSTITUTE

2440 E. Water Well Rd.
Salina, KS 67401

Non-Profit Organization
U.S. Postage Paid
Permit #81
Salina, KS 67401

Address Service Requested

If the date on your label is before 7-1-01, this is your last issue. Please renew your support.